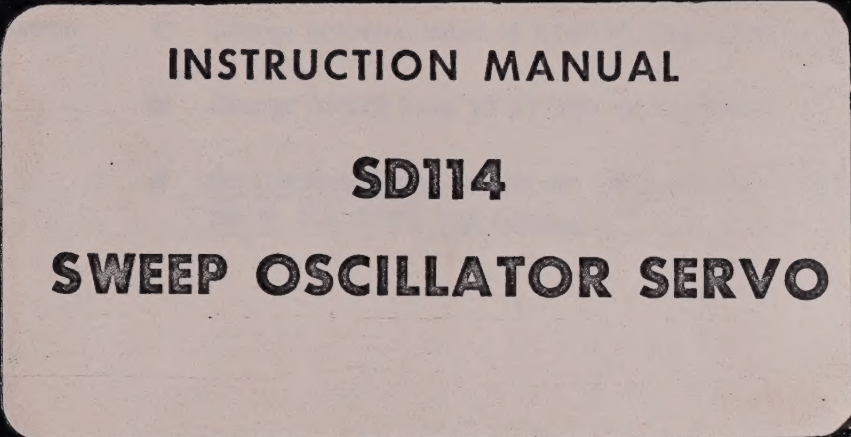




**INSTRUCTION MANUAL**

**SD114**

**SWEEP OSCILLATOR SERVO**



**SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO**



**INSTRUCTION MANUAL**

**SD114**

**SWEEP OSCILLATOR SERVO**

**U.S. PATENT NO. 3,350,651; PATENT PENDING**

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**Telephone: (714) 278-2501**

**TWX: 910-335-2022**

**February, 1969**



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# MANUAL CHANGES

Model: "SOS" Unit

Unit Serial: 011 and on.

Manual Edition: \_\_\_\_\_

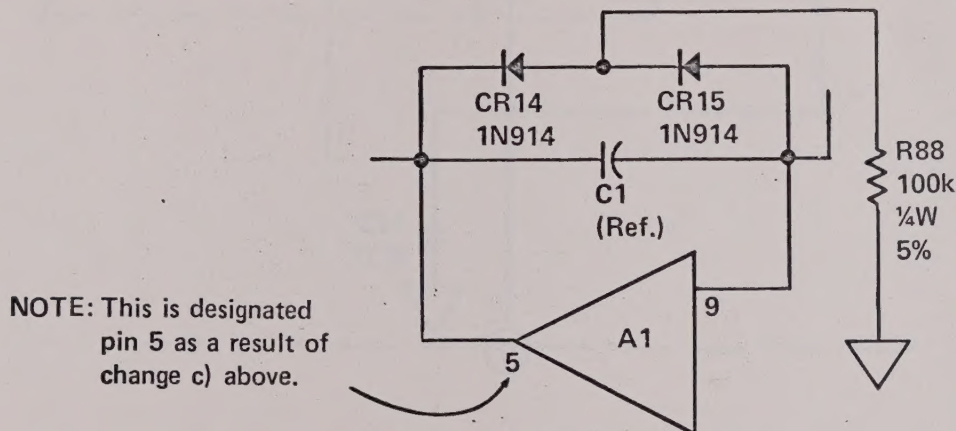
Each change listed below must be individually analyzed for applicability in accordance with "Action" directed relative to unit serial number and/or documentation affected.

## Change #1

ECO-622

Effectivity: S/N 011 and on.

- Action:
- a) Change optimum value of A10R16 from 3.74k to 3.16k.
  - b) Change A5C22 from 10  $\mu$ F/20V to 1  $\mu$ F/50V.
  - c) On schematic only, correct pin designation of A7A1 by changing pin 3 to pin 5. See NOTE that follows.
  - d) To circuit card A7 (Assembly 11362-1), add CR14, CR15 and R88, connected as follows:



- e) Change A1Q1 and A1Q11 from type 2N4250 to type 2N3638A and add  adjacent to each.
- f) Change value of A2R47 and A2R44 from 680 to 200.
- g) Adjacent to A2R22 & A9R49, add , which indicates "FACTORY SELECT WITH OPTIMUM VALUE SHOWN", on schematic.

## Change #2

ECO-623

Effectivity: S/N 024, 031, 034 and on.

(Also applicable to other units below S/N 034 in order for SOS unit to be compatible with SDC Model SD41-1 Sine Signal Loss Detector)

- Action:
- To circuit card A8 (Assembly 11364-1) add resistor R72 (1.5M, 1/4W, 5%) and capacitor C34 (0.18  $\mu$ F), connected as follows:

(Cont'd)



# MANUAL CHANGES

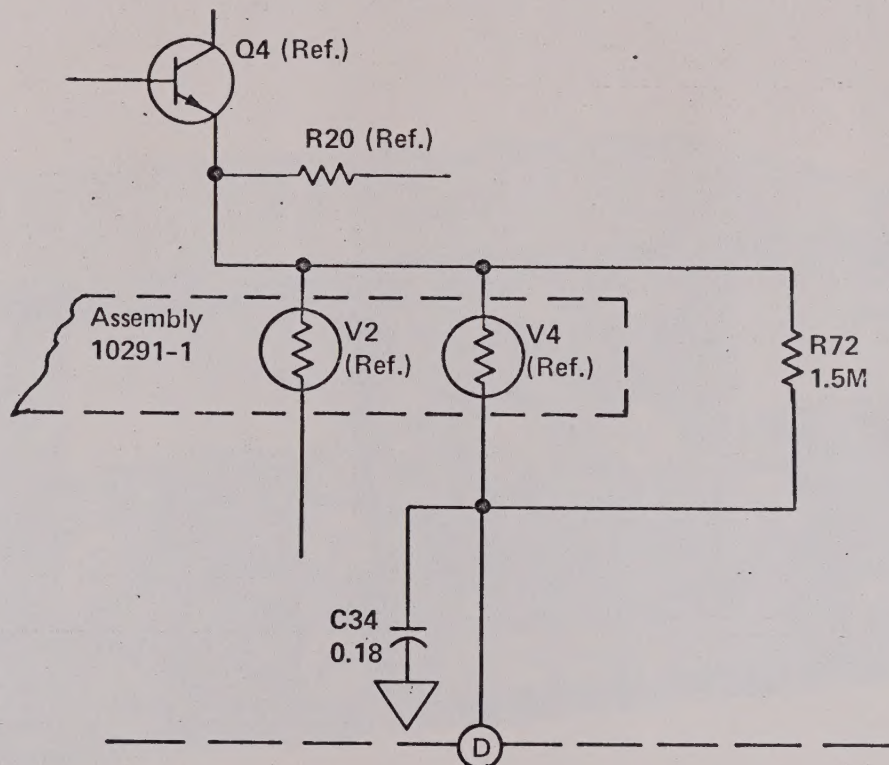
Model: "SOS" Unit (Cont'd)

Unit Serial: 011 and on.

Manual Edition: \_\_\_\_\_

Each change listed below must be individually analyzed for applicability in accordance with "Action" directed relative to unit serial number and/or documentation affected.

## Change #2 (Cont'd)



## Change #3

ECO-622

Effectivity: S/N 011 and on.

Action: Add resistor R52 (1k, 1/4W, 5%) in series with the yellow wire from the wiper of S11A-W2 and pin 4 of circuit card receptacle XA7.

## Change #4

Effectivity: S/N 011 and on.

Action: Correct schematic (Sheet 2) error.

Wire from contact #7 of relay K4 should connect to the bottom side of CR11 instead of the top as shown on the schematic.





MODEL SD114 SWEEP OSCILLATOR SERVO



## PREFACE

### RECEIVING INSPECTION PROCEDURE

The Model SD114 Sweep Oscillator Servo is shipped fully assembled, packed in a polystyrene case designed to protect it against all normal shipping hazards. Immediately upon receipt, inspect the exterior of the shipping case and note any visible damage. Keep all forms and invoices attached to the shipping case. Remove the instrument from the shipping case and test its functional operation in accordance with Section II of this manual. If shipping damage is apparent, file a claim with the carrier's claims agent and send a copy to Spectral Dynamics Corporation. Be sure to include the instrument name, model number, and serial number on all correspondence. Spectral Dynamics Corporation will advise the buyer what should be done; arrangements for repair or replacement will be made as applicable.

### WARRANTY POLICY

All Spectral Dynamics products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain components listed in some of the operating manuals, for the specified period. We will repair or replace products which prove to be defective during the warranty period, providing the failure or damage has not been caused by misuse or abnormal operating conditions. Fuses and lamps are specifically excluded from warranty. If the malfunction or a portion thereof is determined by Spectral Dynamics Corporation to have been caused by misuse or abnormal conditions of operation, an estimate of cost to repair will be submitted to the purchaser for approval before beginning any repair work.

Liability under this warranty is limited to servicing and adjusting the instrument returned to the factory, with transportation charges prepaid by the purchaser. No other warranty is expressed or implied. We are not liable for consequential damages.

If any malfunction develops, notify Spectral Dynamics Corporation or its representative in your area, giving details of the problem, and the name, model and serial number of the equipment. Upon receipt of this information, service data or shipping instructions will be provided.

### RETURN SHIPMENT PROCEDURE

On receipt of shipping instructions, forward the instrument prepaid via air freight to the factory or authorized repair station indicated on the instructions. Replace the instrument in its original shipping case, or surround with two to three inches of shock absorbing material and then pack it in a heavyweight cardboard box, wooden box, or other strong container.



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## SECTION I

### GENERAL INFORMATION

#### 1.1 INTRODUCTION

The Model SD114 Sweep Oscillator Servo provides two basic instruments used in environmental vibration test laboratories. As shown in Figure 1-1, the Model SD114 combines a sweep oscillator and an amplitude servo/monitor in one unit to provide the sinusoidal excitation and amplitude control of a single electrodynamic shaker.

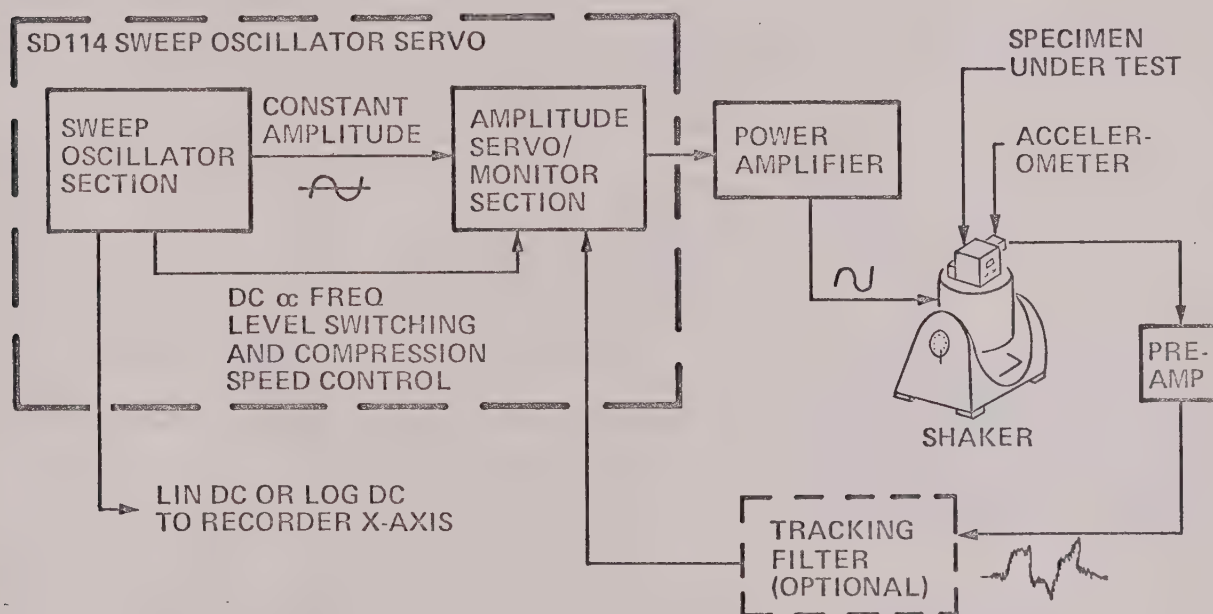


Figure 1-1. Model SD114 Sweep Oscillator Servo, System Concept

#### 1.2 SPECIFICATIONS

FREQUENCY RANGE ..... 5 Hz to 5 kHz

FREQUENCY STABILITY ..... 0.005% of full range,  $\pm 1\%$  of frequency for a period of 8 hours (manually selected frequency)

INPUT SENSITIVITIES ..... Acceleration ... 10 mV (peak)/g (peak)



## 1.2 SPECIFICATIONS (Cont'd)

|                          |                                                                                                    |                                                                                                                                                                  |
|--------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IMPEDANCES.....          | Input .....                                                                                        | Accel: 80 k $\Omega$                                                                                                                                             |
|                          | Output.....                                                                                        | <600 $\Omega$ coupled thru 50 $\mu$ F, 2.5 mA rms maximum                                                                                                        |
| OUTPUT LEVEL .....       | 14 Vrms maximum (5 k $\Omega$ load)                                                                |                                                                                                                                                                  |
| DYNAMIC RANGE.....       | 80 dB minimum (85 dB typical)                                                                      |                                                                                                                                                                  |
| DISTORTION .....         | <1% (5 k $\Omega$ or higher impedance load)                                                        |                                                                                                                                                                  |
| CROSSOVER .....          | Automatic crossover from displacement, velocity (up to 1000 Hz) or acceleration to acceleration    |                                                                                                                                                                  |
| NOISE LEVEL .....        | >80 dB below full output                                                                           |                                                                                                                                                                  |
| RESET OPERATION .....    | Vibration and compression levels can be preset by use of front panel controls prior to actual test |                                                                                                                                                                  |
| COMPRESSOR .....         | Correction Accuracy:                                                                               |                                                                                                                                                                  |
|                          | 20 dB/0.4 dB (0.33 dB typical)                                                                     |                                                                                                                                                                  |
|                          | 40 dB/0.8 dB (0.67 dB typical)                                                                     |                                                                                                                                                                  |
|                          | 60 dB/1.2 dB (0.99 dB typical)                                                                     |                                                                                                                                                                  |
|                          | 80 dB/1.6 dB (1.3 dB typical)                                                                      |                                                                                                                                                                  |
| Operation Modes .....    | Manual.....                                                                                        | Continuously variable over equivalent range of 10-3,000 dB/s                                                                                                     |
|                          | Automatic ...                                                                                      | Continuously variable as a function of excitation frequency with upper & lower limit adjustable from front panel over a range of 10 dB/s to $\approx$ 8,000 dB/s |
| OUTPUTS                  |                                                                                                    |                                                                                                                                                                  |
| Constant Amplitude ..... | 1)                                                                                                 | Sine wave..... 3.5V p-p (open ckt)                                                                                                                               |
|                          |                                                                                                    | Response ..... $\pm$ 0.2 dB, 5 Hz-5 kHz                                                                                                                          |
|                          |                                                                                                    | Distortion ... <0.3%, 20 Hz-2 kHz                                                                                                                                |
|                          |                                                                                                    | <0.5%, 5 Hz-5 kHz                                                                                                                                                |
|                          |                                                                                                    | Impedance ... <100 $\Omega$ , 1 mA rms maximum                                                                                                                   |
|                          | 2)                                                                                                 | Square wave... 5V p-p (open ckt)                                                                                                                                 |
|                          |                                                                                                    | Response ..... $\pm$ 0.02 dB, 5 Hz-5 kHz                                                                                                                         |
|                          |                                                                                                    | Rise and Fall                                                                                                                                                    |
|                          |                                                                                                    | time ..... <500 ns                                                                                                                                               |
|                          |                                                                                                    | Impedance ... <600 $\Omega$ , 1 mA p-p maximum                                                                                                                   |
|                          | 3)                                                                                                 | Triangle wave.. 5V p-p (open ckt)                                                                                                                                |
|                          |                                                                                                    | Response ..... $\pm$ 0.25 dB, 5 Hz-5 kHz                                                                                                                         |
|                          |                                                                                                    | Impedance ... <600 $\Omega$ , 1 mA p-p maximum                                                                                                                   |



## 1.2

### SPECIFICATIONS (Cont'd)

### OUTPUTS (Cont'd)

- |                       |    |                                                    |                                                                                                       |
|-----------------------|----|----------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| DC Analogs . . . . .  | 1) | DC $\propto$ Log Frequency . . .                   | 0 to 1V (open ckt)                                                                                    |
|                       |    | Accuracy . . . . .                                 | $\pm 0.25$ dB after 1-hour warm-up                                                                    |
|                       |    | Impedance . . . . .                                | $< 600\Omega$ , 1 mA maximum                                                                          |
|                       | 2) | (+) and (-) DC $\propto$ Linear Frequency . . .    | 0 to +10V and 0 to $\approx -8.5$ V                                                                   |
|                       |    |                                                    | linearity (best zero-based straight line) $\pm 0.2\%$ of full range                                   |
|                       |    | Impedance . . . . .                                | $< 600\Omega$ , 1 mA maximum                                                                          |
| SWEEP MODES . . . . . | 1) | Linear or logarithmic sweep rates. . . up or down; | single or repetitive                                                                                  |
|                       | 2) | Crossover Freq. . . Can be driven from             | external positive signal source for programming                                                       |
|                       |    | Input Impedance . . . . .                          | 100 k $\Omega$                                                                                        |
|                       |    | Full Range Sensitivity . . . . .                   | +10V                                                                                                  |
|                       | 3) | Manual . . . . .                                   | permits precise frequency setting through combination of coarse and vernier frequency adjust controls |
|                       | 4) | Hold . . . . .                                     | provides short-term stop of sweep at any desired point                                                |
|                       | 5) | Reset . . . . .                                    | sweep can be re-started at either upper or lower limit; $\approx 3$ seconds reset time                |
| SWEEP RATES . . . . . | 1) | Log Sweep . . . . .                                | 0-10 decades/minute, continuously variable                                                            |
|                       | 2) | Linear Sweep . . . . .                             | 0-1,000 Hz/s, continuously variable                                                                   |
|                       |    |                                                    | Accuracy (% of setting)                                                                               |
|                       |    | Sweep Rate Control                                 | Log Mode                      Linear Mode                                                             |
|                       |    | 1 -10                                              | $\pm 3\%$ $\pm 1\%$                                                                                   |
|                       |    | 0.5-1.0                                            | $\pm 5\%$ $\pm 3\%$                                                                                   |
|                       |    | 0.1-0.5                                            | $\pm 10\%$ $\pm 10\%$                                                                                 |
|                       |    | 0 -0.1                                             | (Usable but not calibrated)                                                                           |



## 1.2 SPECIFICATIONS (Cont'd)

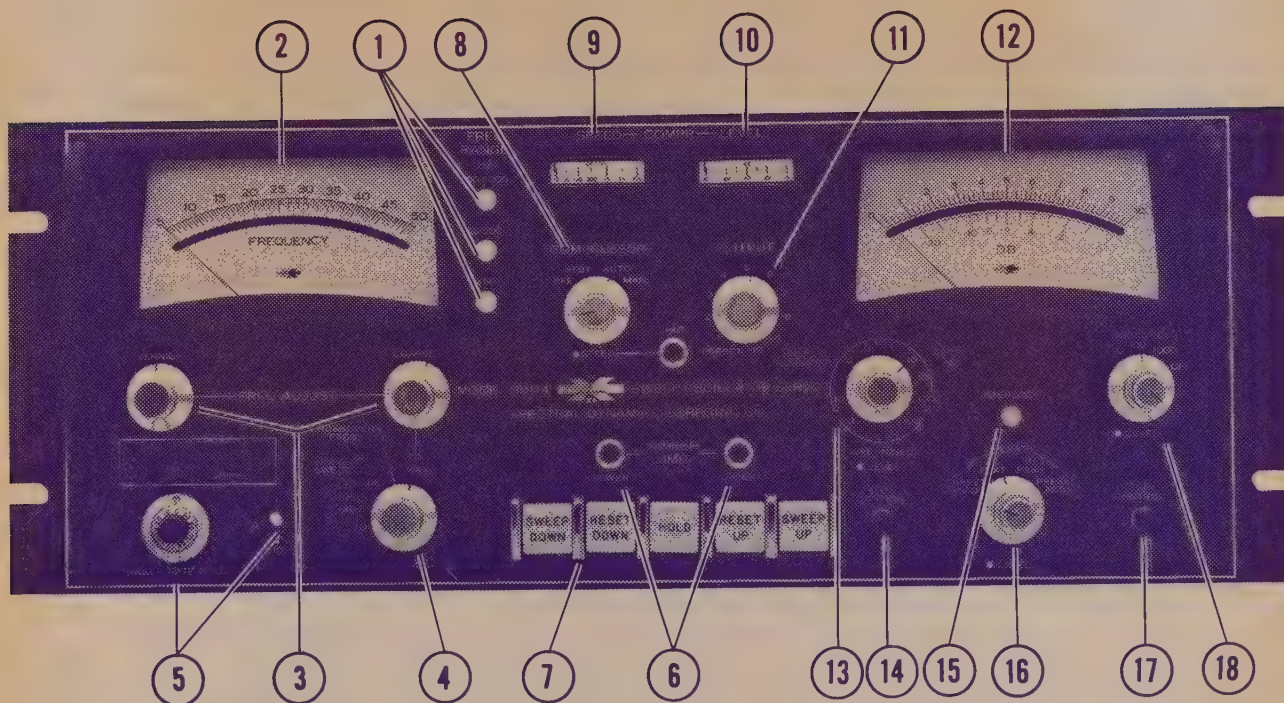
### CONTROL RANGES

(Accel Input Only)

| Full Scale Ranges ..... | Accel (g) | Velocity (in/s) | Displ (in p-p) |
|-------------------------|-----------|-----------------|----------------|
|                         | 1000      | 100             | 10             |
|                         | 100       | 10              | 1              |
|                         | 10        | 1               | 0.1            |
|                         | 1         | 0.1             | 0.01           |

|                  |                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MONITORING ..... | 1) Acceleration, velocity, or displacement ( $A_1$ input only) or acceleration ( $A_2$ input)<br>Accuracy ... $\pm 4\%$ full scale, 10 Hz-5 kHz,<br>down $\approx 4\%$ at 5 Hz                                                                                                                                                                                                       |
|                  | 2) Compression Level                                                                                                                                                                                                                                                                                                                                                                 |
|                  | 3) Compression Speed                                                                                                                                                                                                                                                                                                                                                                 |
|                  | 4) Frequency Display:<br>Meter with automatic range selection<br>Each decade of 3-decade range displayed automatically<br>Meter lights indicate scale.<br>Accuracy ... 2% of reading after 1-hr warmup                                                                                                                                                                               |
| INTERLOCK .....  | All front panel switches involving mode or range of operation are interlocked. If a potentially harmful change is made to a switch setting during a test, the servo output is reduced to at least 76 dB below full output at the operating compression speed. At the option of the user, the interlock feature may be bypassed by the use of jumpers at the rear-chassis connectors. |
| POWER .....      | 105-125/210-250 Vac (switch-selectable); 50-400 Hz;<br>$\approx 50W$                                                                                                                                                                                                                                                                                                                 |
| CONNECTORS ..... | All outputs available at BNC connectors and 26-pin Cannon plug on rear of chassis                                                                                                                                                                                                                                                                                                    |
| DIMENSIONS ..... | Height ..... 7" (17,8 cm)<br>Width ..... 19" (48,3 cm)<br>Depth ..... 15" (38,10 cm)<br>Shipping Weight ..... 25 lbs (11,3 kg)                                                                                                                                                                                                                                                       |





The circled numbers are keyed to the functional descriptions given in paragraph 1.3.

Figure 1-2. Front Panel Description



## 1.3 FRONT PANEL DESCRIPTION

The descriptions given in the following paragraphs are keyed by circled numbers to their associated front-panel control, meter, indicator, or connector as shown in Figure 1-2, Front Panel Description. All interacting controls, indicators, etc., have been grouped to maintain continuity of description.

### 1 FREQ RANGE (Hz) Indicators:

Light individually to indicate output frequency range 5-50, 50-500, or 500-5,000 Hz.

### 2 FREQUENCY Meter:

Linearly calibrated from 5 to 50, indicates output frequency from 5 Hz to 5,000 Hz in three ranges; meter range multiplier 1, 10, or 100 is visually determined by lighted FREQ RANGE (Hz) indicator 5-50, 50-500, or 500-5,000 respectively.

### 3 FREQ ADJUST Controls:

COARSE

10-turn potentiometer, provides continuously variable frequency adjustment from 5 Hz to 5,000 Hz.

VERNIER

Provides vernier frequency adjustment about any setting of the COARSE FREQ ADJUST; provides overall adjustment of  $\approx 2.5$  Hz on 5-50 range,  $\approx 5$  Hz on 50-500 range, and  $\approx 10$  Hz on 500-5,000 range.

### 4 Function Selector:

Selects log or linear frequency sweep mode, manual frequency adjust mode, or crossover frequency adjust mode.

LOG SWEEP/LINEAR SWEEP Modes:

SINGLE ..... Oscillator sweeps once from LOWER to UPPER or from UPPER to LOWER sweep limits as initiated by pressing sweep control push buttons.

HOLD ADJ ..... Places oscillator in HOLD ADJ mode as follows: With oscillator sweeping up or down, press HOLD push button to stop sweep; HOLD button will light. Set Function Selector to HOLD ADJ. (Refer to operation of sweep control push buttons and paragraph 2.2.1, steps m. and n.)



## 1.3 FRONT PANEL DESCRIPTION (Cont'd)

### 4 (Cont'd)

- AUTO** ..... Oscillator continuously sweeps up and down between upper and lower sweep limits until operational mode is changed; i.e., if HOLD push button is pressed, or if function switch is changed. In AUTO mode, direction of sweep can be changed by pressing opposite SWEEP UP or DOWN push button.
- MAN** ..... Oscillator frequency is adjusted manually using COARSE and VERNIER FREQ ADJUST controls previously described.
- CROSSOVER FREQ** ..... Oscillator frequency is controlled by CROSSOVER FREQ adjust potentiometer; used when presetting crossover frequency between A, V, or D level of A-V-D channel and A level of ACCEL channel. Refer to description of servo monitor section controls.

### 5 SWEEP RATE (0-10) and Multiplier A, 1/10:

Setting determines sweep rate for log and linear sweep modes selected by function switch. Use formulas printed on panel to compute sweep rate. For examples:

**LOG (DEC/MIN) = XR x .1A** .. means that with function switch in any LOG SWEEP position, the sweep rate in decades per minute equals the SWEEP RATE control setting multiplied by one-tenth the A switch setting.

**LIN (Hz/SEC) = SR x A** ..... means that with function switch in any LINEAR SWEEP position, the frequency sweep rate in Hz per second equals the SWEEP RATE control setting multiplied by the "A" switch setting.

### 6 LOWER/UPPER SWEEP LIMIT:

Screwdriver adjust potentiometer used to adjust sweep lower and upper frequency limits.

### 7 Sweep Control Push Button Switch/Indicators:

**SWEEP DOWN** ... Lights to indicate when oscillator is sweeping down. In SINGLE sweep mode, press to initiate down-sweep; sweep stops at lower limit. In HOLD ADJ mode, press to sweep down. (SWEEP DOWN does not light in this mode.) Sweep stops when SWEEP DOWN button is released. In AUTO mode, may be used to reverse direction of an up-sweep to a down-sweep.



## 1.3 FRONT PANEL DESCRIPTION (Cont'd)

### 7 (Cont'd)

**SWEEP UP** ..... Lights to indicate when oscillator is sweeping up. Used to initiate up-sweeps in same manner as SWEEP DOWN push button described above.

**RESET DOWN** ... Lights to indicate that oscillator is at lower sweep frequency limit. If pressed in any sweep mode, oscillator will quickly sweep down to lower sweep frequency limit and stop sweeping. At this point, LOWER SWEEP LIMIT potentiometer may be adjusted for desired lower sweep frequency limit. Inoperative in HOLD ADJ mode.

**RESET UP** ..... Lights to indicate that oscillator is at upper sweep frequency limit. If pressed in any sweep mode, oscillator will quickly sweep up to upper sweep frequency limit and stop sweeping. At this point, UPPER SWEEP LIMIT potentiometer may be adjusted for desired upper sweep frequency limit. Inoperative in HOLD ADJ mode.

**HOLD** ..... Pressed to stop up or down sweep; lights to indicate sweep is stopped. Oscillator may then be placed in HOLD ADJ mode with function selector switch. (Refer to HOLD ADJ mode described under Function Selector.)

### 8 COMPRESSOR Mode Switch and SPEED Control:

Used to select four compressor modes of operation:

**OFF** ..... Compressor circuit does not control SERVO OUTPUT (oscillator) signal level. The sweep oscillator output bypasses the compressor circuit and is controlled manually by front-panel OUTPUT control. (Switch is interlocked between STBY and OFF positions. This interlock causes the compressor to go into full compression if moved from STBY to OFF when OUTPUT control is not fully CCW. Refer to OUTPUT control, PRESET position described below.)

**STBY** ... Compressor is in full compression: SERVO OUTPUT signal level is  $\approx 80$  dB below 14 Vrms.

**AUTO** ... Compressor speed (dB per second) increases at the rate determined by the SPEED control, as oscillator frequency increases, until compressor speed limit is reached, as set by the LIMIT adjust potentiometer.

**MAN** ... Compressor speed is manually adjusted by SPEED control, and is not affected by the operating frequency.



### 1.3 FRONT PANEL DESCRIPTION (Cont'd)

#### 8 (Cont'd)

##### **SPEED (Compressor):**

Used to manually adjust compressor speed when operating in COMPRESSOR MAN. and AUTO modes.

#### 9 COMPR SPEED Meter:

Indicates compression speed in dB per second, from 10 dB/second to 10,000 dB/second.

#### 10 COMPR LEVEL Meter:

Indicates compression level in dB, from 0 dB to -80 dB.

#### 11 OUTPUT:

Used to manually control SERVO OUTPUT signal level when COMPRESSOR mode switch is set to OFF, also controls maximum output in AUTO and MAN. modes. PRESET position, switch detent at maximum CCW, is used during PRESET mode (paragraph 2.2.2) and to bring compressor out of full-compression interlock mode. (Refer to paragraph 2.3.)

#### 12 DB Meter:

In PRESET mode, indicates A, V, or D control level as adjusted by ACCEL and A-V-D LEVEL controls. In OPERATE mode, indicates controlled accelerometer level.

#### 13 A-V-D Range Switch and LEVEL Control:

Selects A-V-D channel control-range of A (acceleration) at 1, 10, 100 or 1,000g; V (velocity) at .1, 1, 10, or 100 inches/second; or D (displacement) at .01, .1, 1 or 10 inches peak-to-peak. The LEVEL control varies A, V, or D level over the range selected by A-V-D switch.

#### 14 A-V-D CONTROL Indicator:

Is lighted when A-V-D channel is controlling compressor.



## 1.3 FRONT PANEL DESCRIPTION (Cont'd)

### 15 INTERLOCK Indicator:

Is lighted when the closed-circuit switch-interlock system has been interrupted; compressor is driven into full compression ( $\approx 80$  dB).

### 16 PRESET/OPERATE Mode Switch and LEVEL Control:

PRESET A-V-D ..... In this mode the A-V-D range switch is set to desired A, V, or D control function and range, the PRESET LEVEL control is adjusted for the desired vibration control level as indicated on the DB meter, and then the A-V-D LEVEL control is adjusted for a COMPR LEVEL meter reading equal to the test idling level.

PRESET ACCEL ..... In this mode the ACCEL range switch is set to the desired acceleration range, the PRESET LEVEL control is adjusted for the desired control level indicated on the DB meter, and then the ACCEL LEVEL control is adjusted for a COMPR LEVEL meter reading equal to the test idling level.

OPERATE FLAT/HI PASS ... For normal servo amplitude control, this switch must be in either OPERATE FLAT or HI PASS position. The HI PASS position places a 25-Hz high-pass filter in series with the SERVO OUTPUT; this is recommended when constant displacement tests are run at the higher frequencies.

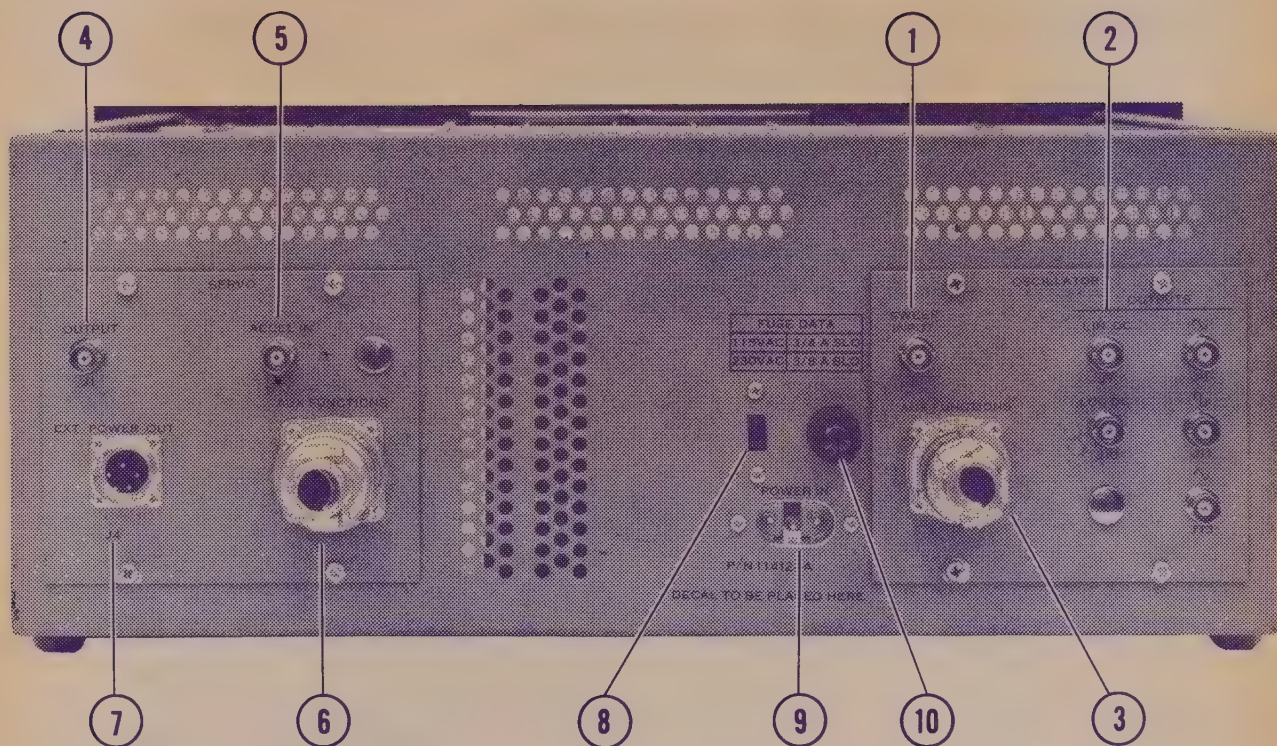
### 17 ACCEL CONTROL Indicator:

Is lighted when ACCEL channel is controlling compressor.

### 18 ACCEL (g) Range Switch and LEVEL Control:

Selects ACCEL channel control-range of acceleration at 1, 10, 100 or 1,000g. The OFF position inhibits the automatic crossover switching circuit, thus A-V-D channel controls compressor throughout frequency sweep.





# NOTE

The circled numbers are keyed to the functional descriptions given in paragraph 1.4.

Figure 1-3. Rear Chassis Description



## 1.4 REAR CHASSIS DESCRIPTION

### 1 OSCILLATOR SWEEP INPUT (J6):

Accepts external sweep control voltage, 10 mV to 10V (5 Hz to 5 kHz); front-panel function selector must be set to CROSSOVER FREQ, and PRESET/OPERATE mode switch must be in OPERATE (FLAT or HI PASS).

### 2 OSCILLATOR OUTPUTS:

LIN DC (J7) ..... Provides a d-c voltage, 10 mV to 10V proportional to oscillator frequency range, 5 Hz to 5 kHz.

LOG DC (J10) ..... Provides a d-c voltage, 10 mV to 10V, proportional to the log of the oscillator frequency range 5 Hz to 5 kHz.

$\sim$  (J8),  $\square$  (J11),  $\wedge$  (J13)... Provide constant level outputs; 1 Vrms sine wave; 5V p-p square wave, and 5V p-p triangular wave.

### 3 OSCILLATOR AUX FUNCTIONS (J9):

Provides input and output connections in one cable for system interconnections. (See schematic drawing for wiring information.)

### 4 SERVO OUTPUT (J1):

Provides servo-amplitude-controlled sweep-oscillator signal to an external shaker power amplifier.

### 5 SERVO ACCEL IN (J2):

Accepts control accelerometer output signal for processing to A, V, or D compressor control voltages.

### 6 SERVO AUX FUNCTIONS (J5):

Provides input and output connections for control and interlock functions for system interconnections. (See schematic drawing for wiring information.)

### 7 EXT POWER OUT (J4):

Provides unregulated +38V and -38V d-c for powering an associated SDC Model SD117 Automatic Level Programmer when used.



## SECTION II

### OPERATION

#### 2.1 GENERAL

The SOS (Sweep Oscillator Servo) provides the sinusoidal excitation and amplitude control for a single electro-dynamic shaker. If the instrument was purchased as part of a system, refer to the applicable system instruction manual which includes installation and operation instructions for the SOS. Refer to paragraphs 1.3 and 1.4 in Section I of this manual for the description of all operating controls, indicators, and connectors.

#### 2.2 OPERATIONAL CHECK

The following procedure checks the overall operational performance of both the sweep oscillator section and the amplitude servo/monitor section.

##### 2.2.1 Sweep Oscillator Section

- ✓ a. Check that the 115/230 switch on the rear chassis is set to the expected line voltage and that the correct value fuse is installed.
- ✓ b. Make connections between the SOS and H-P 350D Attenuator (adjusted for 25 dB attenuation) as shown in Figure 2-1. Ensure that jumpered plugs P5 and P9 are inserted. Figure 2-2 shows construction details for plugs P5 and P9.
- c. Connect the power cord to the primary power source and allow at least 1-hour warmup. (There is no power switch on the SOS.)

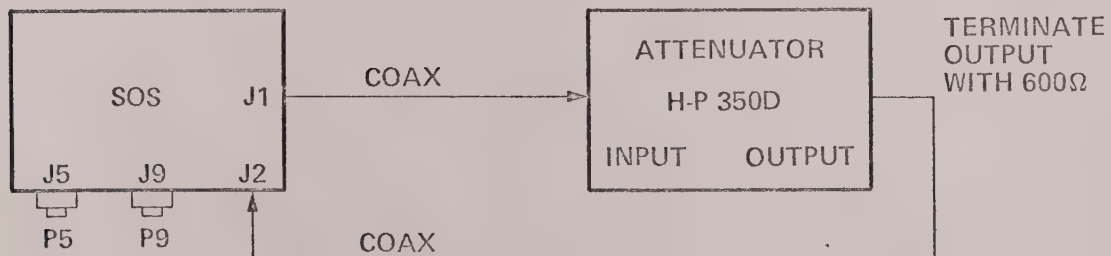
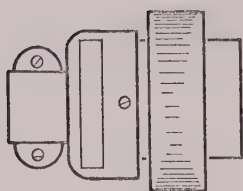


Figure 2-1. Setup for Operational Check

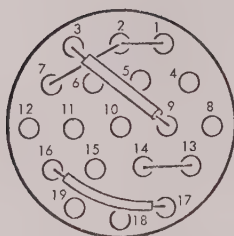




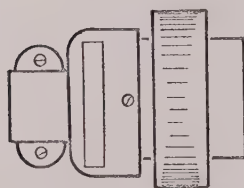
SK-19-21C-1/2

Use No. 22 bus wire and connect:

| FROM | TO          |
|------|-------------|
| 1    | 2           |
| 2    | 7           |
| 5    | 6           |
| 3    | 9 (sleeve)  |
| 13   | 14          |
| 16   | 17 (sleeve) |

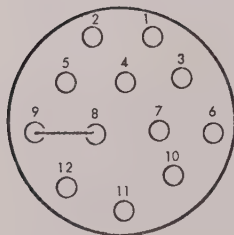


P5



GK-12-21C-1/2

Use No. 22 bus wire and connect  
8 to 9.



P9

Figure 2-2. Jumpered Plugs P5 and P9, Construction Details



## 2.2.1 Sweep Oscillator Section (Cont'd)

Although a 1-hour warmup should be allowed for best oscillator stability, the oscillator section can be operationally checked immediately.

- d. Set oscillator function switch to MAN.
- e. Turn the COARSE FREQ ADJUST fully counter-clockwise. The 5-50 Hz FREQ RANGE indicator should be lighted, and the FREQUENCY meter should read  $\approx 5$ .
- f. Slowly rotate the COARSE FREQ ADJUST clockwise and observe the action of the FREQUENCY meter and the FREQ RANGE indicators. When the FREQUENCY meter reads  $\approx 51$  Hz, the 50-500 Hz indicators will light and the meter will read  $\approx 5$  (read as 50 Hz). As the COARSE control is advanced further, a second range change will occur at  $\approx 510$  Hz; the 500-5,000 Hz indicator will light and the meter needle will again drop to 5 (read as 500 Hz). Continue rotating COARSE control until meter reads 50 (5,000 Hz).
- g. Rotate the COARSE FREQ ADJUST counter-clockwise to  $\approx 25$  Hz. Then rotate VERNIER control fully CW and then CCW, FREQUENCY meter should indicate  $\approx 2.5$  Hz overall variation about the COARSE setting.
- h. Set SWEEP RATE (0-10) control to 5 and multiplier A switch to 10. (This is a moderate sweep speed to observe sweep action.)
- i. Set oscillator function switch to LOG SWEEP SINGLE, and press RESET DOWN. Varying LOWER SWEEP LIMIT from full CW to full CCW should vary FREQUENCY from 5 Hz to  $\approx 500$  Hz. Make final adjustment for 5-Hz lower sweep limit.
- j. Press RESET UP. Varying UPPER SWEEP LIMIT from full CW to full CCW should vary FREQUENCY from  $\approx 500$  Hz to 5,000 Hz. Make final adjustment for 5,000-Hz upper sweep limit.
- k. Set oscillator function switch to LOG SWEEP SINGLE. Alternately press SWEEP UP and SWEEP DOWN push buttons and observe single sweep action.
- l. Set oscillator function switch to LOG SWEEP AUTO. Press either SWEEP DOWN or SWEEP UP push button to start sweep. Observe FREQUENCY meter and FREQ RANGE indicators; output frequency should continuously sweep up and down between upper and lower limits as previously set (5 Hz to 5,000 Hz).
- m. While a sweep is in progress (about center scale on any range), press the HOLD push button. Sweep will stop. Set oscillator function switch to HOLD ADJ.



## ✓ 2.2.1 Sweep Oscillator Section (Cont'd)

- ✓ n. Press SWEEP DOWN; oscillator will sweep down until button is released. Press SWEEP UP; oscillator will sweep up until button is released. Note that if either RESET UP or RESET DOWN push button lights, the oscillator will stop sweeping. To return to HOLD ADJ mode, set the oscillator function switch to SINGLE; initiate a sweep with either SWEEP UP or SWEEP DOWN push button; press HOLD button at  $\approx 2,500$  Hz. and then return oscillator function switch to HOLD ADJ.
- ✓ c. Check LINEAR SWEEP modes by repeating procedures of steps i. through n. using SINGLE, AUTO, and HOLD ADJ LINEAR SWEEP positions of oscillator function switch.

## W 2.2.2 Servo Monitor Section

The test parameters selected for this check are as follows:

Log sweep rate is 1 octave per minute.

Sweep range is 10 Hz to 2 kHz.

Up sweep is started with servo controlling 0.05 inches p-p constant displacement. A smooth crossover to 5g constant acceleration is computed to occur at 44.2 Hz.

Set front-panel controls as follows:

SWEEP RATE (0-10) to 3.32 and multiplier A switch to 1.

(from the formula,  $\text{LOG (OCT/MIN)} = \text{SR} \times .332 \text{ A}$ ,  $\text{LOG (OCT/MIN)} = 3.32 \times .332 \times 1 = 1 \text{ octave/min}$ ).

Oscillator function switch to MAN.

COMPRESSOR switch to AUTO.

OUTPUT control to full CCW, PRESET switch detent.

OPERATE/PRESET switch to A-V-D PRESET position.

- a. Adjust PRESET LEVEL control for 0.05 in. p-p, reading of 5 on DB meter.
- ✓ b. Adjust A-V-D LEVEL control for 30 dB reading on COMPR LEVEL meter.
- ✓ c. Set OPERATE/PRESET switch to ACCEL PRESET position, and ACCEL range switch to 10.
- ✓ d. Adjust PRESET LEVEL control for 5g reading of 5 on DB meter.
- ✓ e. Adjust ACCEL LEVEL control for 30 dB reading on COMPR LEVEL meter.
- f. Set oscillator function switch to CROSSOVER FREQ, and adjust CROSSOVER FREQ control for 44.2 Hz on FREQUENCY meter (5-50 Hz indicator is lighted).



### 2.2.2 Servo Monitor Section (Cont'd)

- ✓ g. Set oscillator function switch to LOG SWEEP SINGLE and press RESET DOWN push button. *Reset Down lights up automatically*
- ✓ h. Adjust LOWER SWEEP LIMIT control for 10 Hz.
- ✓ i. Press RESET UP and adjust UPPER SWEEP LIMIT for 2,000 Hz. (FREQUENCY meter reads 20; 500-5,000 Hz indicator is lighted.)
- ✓ j. Press RESET DOWN; oscillator FREQUENCY should sweep down to 10 Hz and stop sweeping.
- ✓ k. Set OPERATE/PRESET switch to OPERATE FLAT and adjust SPEED control for 10 dB/s indication on COMPR SPEED meter.
- l. Set COMPRESSOR switch to STBY and wait for an indication below 80 dB on the COMPR LEVEL meter.
- ✓ m. Adjust OUTPUT LEVEL control fully clockwise to 10, and set COMPRESSOR switch to AUTO. Observe that the A-V-D CONTROL indicator is lighted and the DB meter reads  $\approx 5$ . This reading might be slightly high because of the compressor dynamics required for displacement control (12 dB per octave). *Reads*
- ✓ n. Press SWEEP UP push button and observe servo operation: As the frequency sweeps up, the following indications should be evident for proper operation:
  - 1) COMPR SPEED meter reading increases slowly from 10 dB to  $\approx 400$  dB/SEC.
  - 2) COMPR LEVEL meter reading decreases from  $\approx 60$  dB to  $\approx 35$  dB. *20*
  - 3) The A-V-D CONTROL indicator extinguishes and the ACCEL CONTROL indicator is lighted as the oscillator sweep passes through the crossover frequency (44.2 Hz).
  - 4) DB meter indicates constant control at reading of  $\approx 5$  throughout the frequency sweep.

### 2.3 OPERATION

#### NOTE

Before actual operation in a shaker system, it is recommended that the operator become familiar with programming the oscillator sweep frequency limits, crossover frequency, A-V-D and ACCEL preset etc. by performing the OPERATIONAL CHECK of paragraph 2.2. For this check, an H-P 350D attenuator is substituted for the shaker system.



## 2.3 OPERATION (Cont'd)

For normal operation, proceed as follows:

- a. Outline the operational program by listing the desired A-V-D and ACCEL levels (if both are applicable), the computed crossover frequency (if applicable), the sweep frequency range (upper and lower limits), sweep rate, and compressor speed and speed limit. The usable A, V, and D parameters are included within the heavy outlines on the graphs of Figures 2-3, 2-4, and 2-5.
- b. Set the OUTPUT control to PRESET (full CCW in switch detent.)
- c. Adjust shaker system MASTER GAIN to OFF.
- d. Apply power to system and allow at least a 1-hour warmup.
- e. Set SWEEP RATE (0-10) control and multiplier A switch as required; compute settings using applicable formula printed on front panel.
- f. Set oscillator function switch to MAN., COMPRESSOR switch to AUTO, and OPERATE/PRESET switch to A-V-D PRESET position.
- g. Set A-V-D and ACCEL range switches to proper settings in accordance with the program levels.
- h. Adjust PRESET LEVEL control for desired A, V, or D parameter level as read on the DB meter.
- i. Adjust A-V-D LEVEL control for compression level compatible with system dynamics (usually  $\approx 30$  dB) as read on the COMPR LEVEL meter.

If an A-A, V-A, D-A (2-level) program requiring a crossover is being preset, perform the following step j., k., etc. If only a single level A, V, or D program is being preset, set ACCEL range switch to OFF and proceed to step n.

- j. Set OPERATE/PRESET switch to ACCEL PRESET.
- k. Adjust PRESET LEVEL control for desired acceleration level as read on the DB meter.
- l. Adjust ACCEL LEVEL control for COMPR LEVEL meter reading as programmed in step i.
- m. Set oscillator function switch to CROSSOVER FREQ, and adjust the CROSSOVER FREQ control so that the FREQUENCY meter reads the computed crossover frequency.



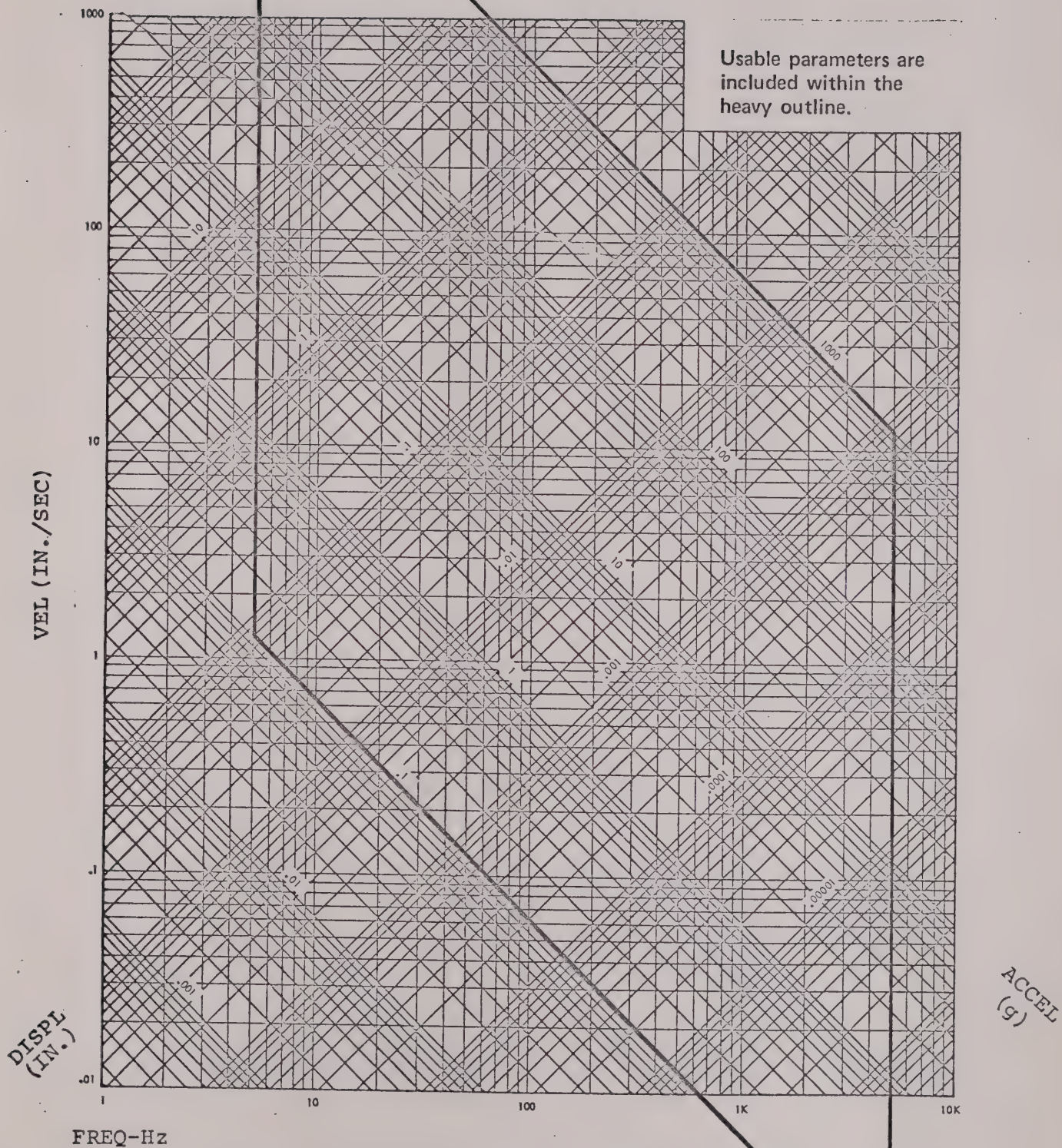


Figure 2-3. Acceleration Parameters



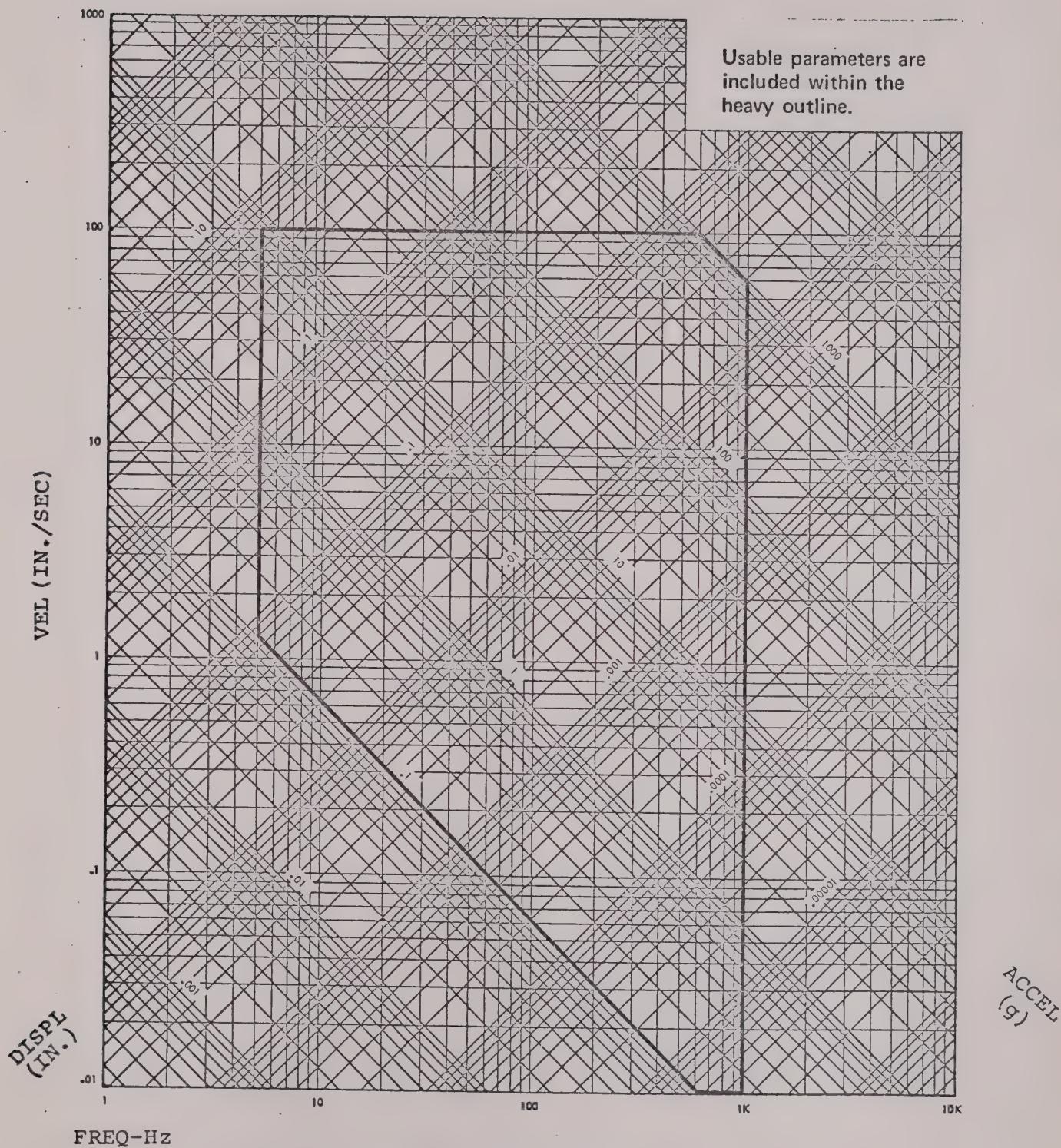


Figure 2-4. Velocity Parameters



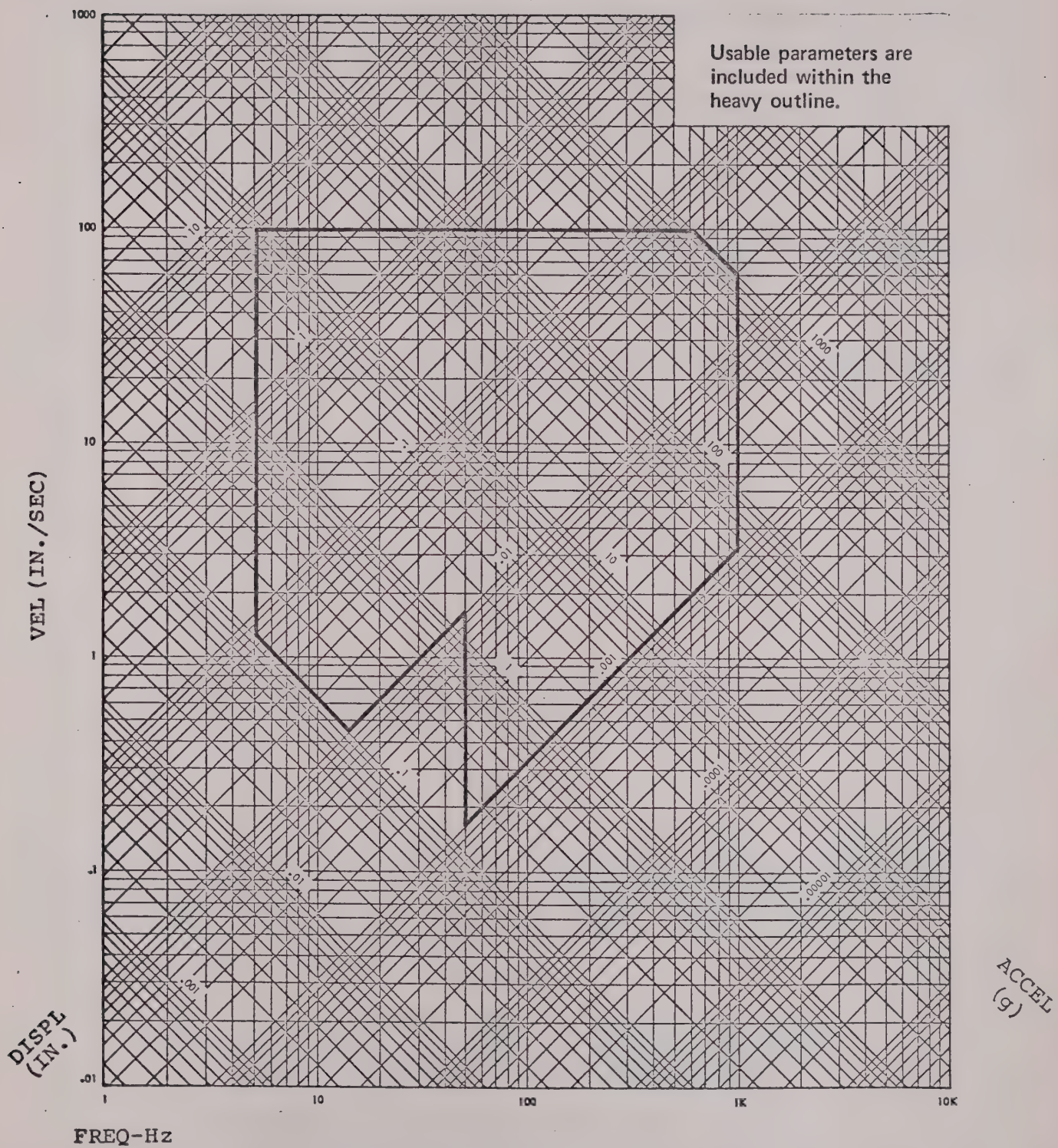


Figure 2-5. Displacement Parameters



## 2.3 OPERATION (Cont'd)

- n. Set oscillator function switch to SINGLE (LOG or LINEAR as applicable).
- o. Press RESET DOWN push button and adjust LOWER SWEEP LIMIT control for desired low frequency sweep limit (within 5- to 500-Hz range).
- p. Press RESET UP push button and adjust UPPER SWEEP LIMIT control for desired upper frequency sweep limit (within 500- to 5,000-Hz range).
- q. Press RESET DOWN; oscillator will sweep down to lower frequency limit and stop sweeping.
- r. Adjust SPEED control for desired reading on COMPR SPEED meter. (Note that the compressor speed (reaction time to change) should always be slower than any other element in the system, including the specimen.) Figure 2-6 shows a family of curves for various SPEED control settings and LIMIT ranges.
- s. Set OPERATE/PRESET switch to OPERATE FLAT (or HI PASS if running high frequency displacement tests; however, note that a slightly higher distortion will be evident at frequencies below 25 Hz when using the HI-PASS OPERATE mode.)
- t. Set COMPRESSOR switch to STBY, and wait for COMPR LEVEL meter to read below 80 dB.
- u. Adjust the OUTPUT LEVEL control fully clockwise to 10; then set the COMPRESSOR mode switch to AUTO.

The SOS is now programmed. The test is started by pressing the SWEEP UP push button.

### NOTE

If the INTERLOCK indicator lights during operation, rotate OUTPUT control full CCW (into PRESET switch detent). Determine cause of interlock condition; then resume test in normal fashion.

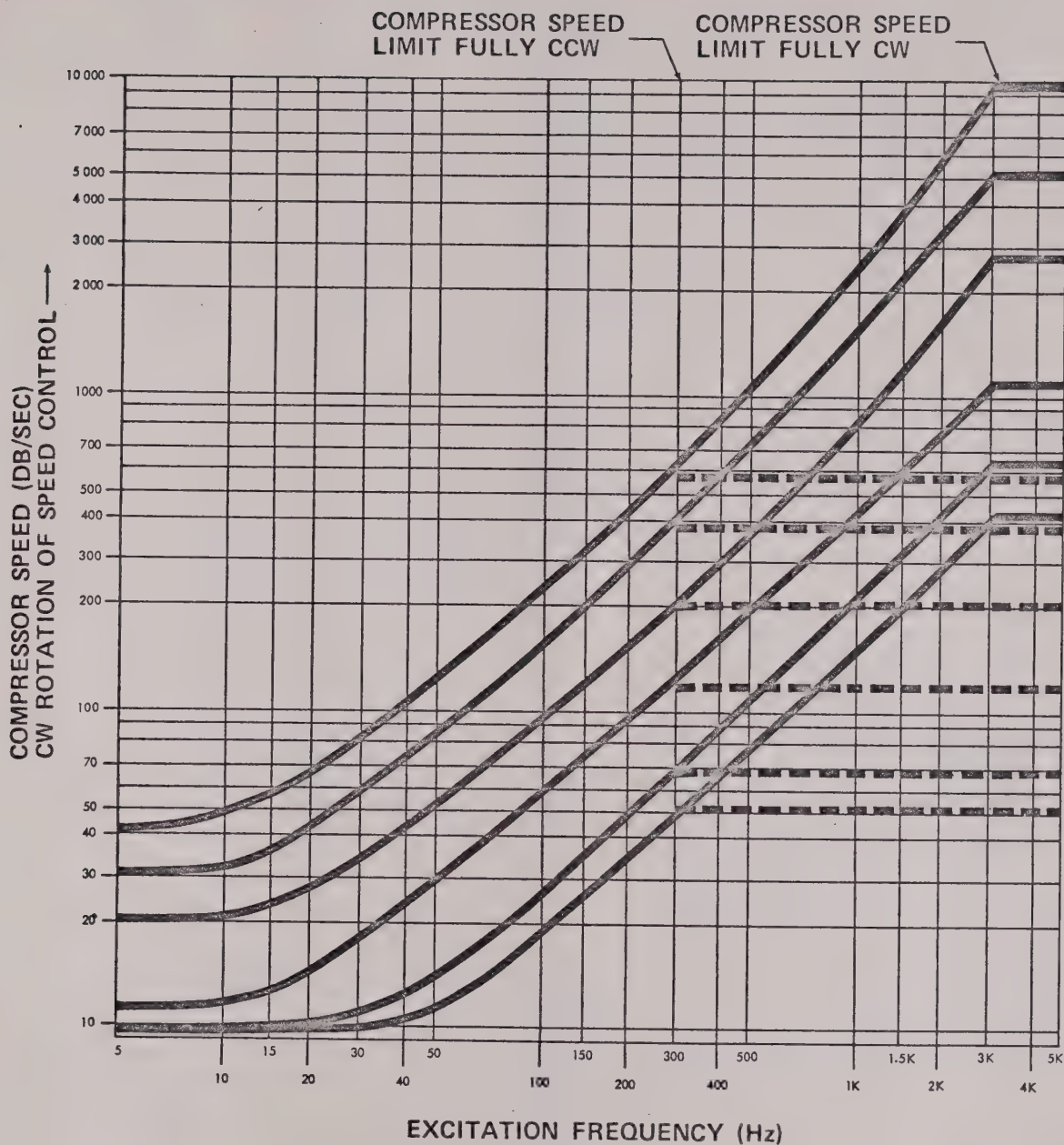
## 2.4 APPLICATIONS

As shown in Figure 1-1 in Section I of this manual, a tracking filter can be used in the servo loop to provide a sinusoidal acceleration feed-back signal at the fundamental system tuning frequency. Figure 2-7 shows the interconnections required when using an SDC Model SD101B Dynamic Analyzer as a tracking filter with the SOS. For automatic level control of acceleration, velocity, and displacement, an SDC Model SD117 Automatic Level Programmer is used. See Figure 2-8 for the interconnections required.

### CAUTIONS

- 1) The SDC Model SD117 receives its operating power from the SOS. However, make certain the SOS is disconnected from its primary power source before interconnecting the SDC Model SD117.
- 2) The OPERATE/PRESET switch must be set to FLAT or HI PASS when the Oscillator section is used independently as a VCO and controlled by an external d-c voltage applied to J6, OSCILLATOR SWEEP INPUT.





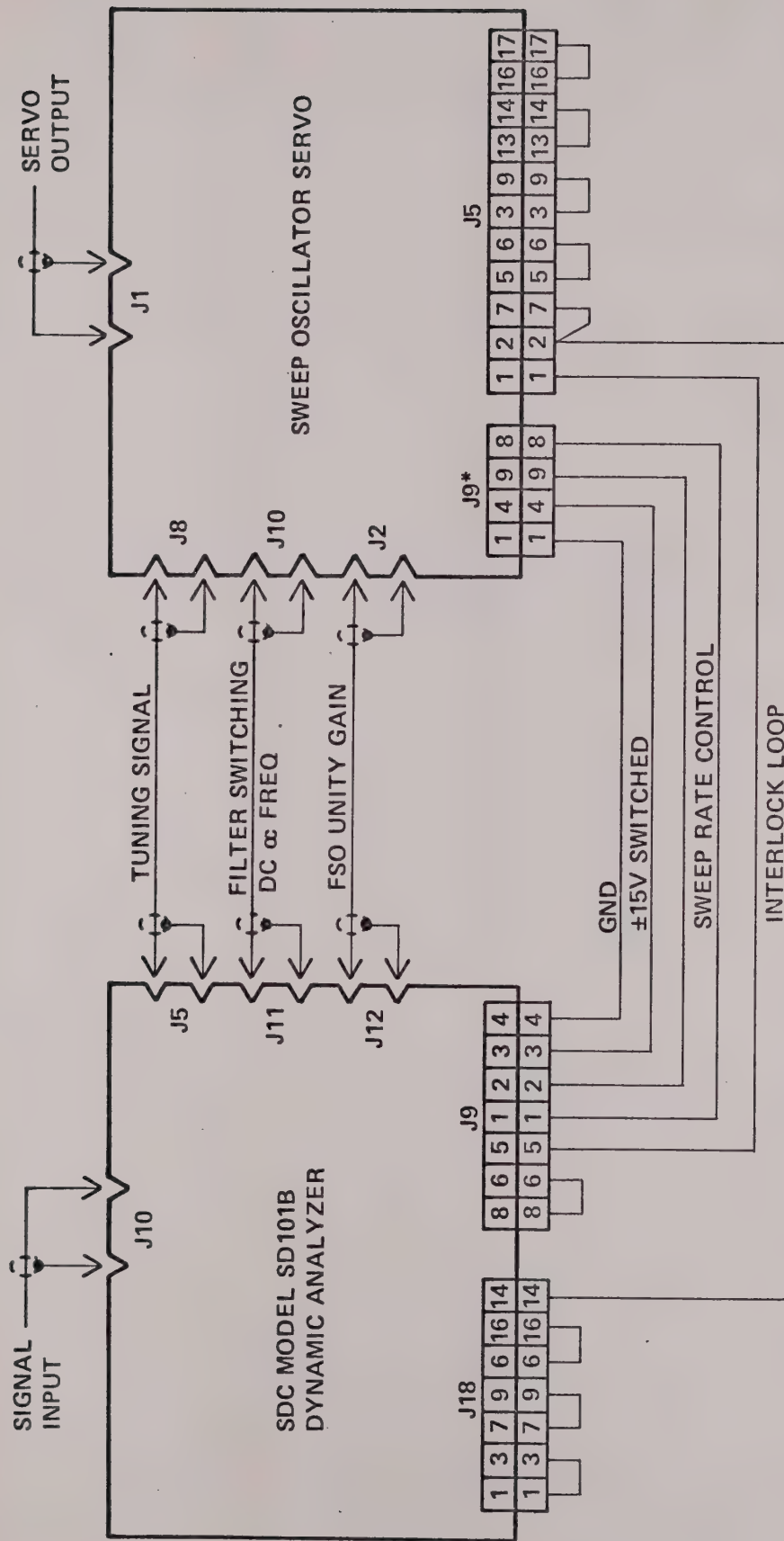
**NOTES:**

1. Solid Lines = LIMIT Control maximum (CW)  
Dashed Lines = LIMIT Control minimum (CCW)
2. The graph shows the range of adjustment for the COMPRESSOR SPEED control with the associated range of adjustment of the LIMIT control.

With the LIMIT control in the counter-clockwise position, the COMPRESSOR SPEED response follows the solid line until it intersects the dashed line, after which the response follows the dashed line.

Figure 2-6. Range Compressor Speed Control





\*If sweep rate control is not desired,  
 jumper J9-8 to J9-9 on SOS, and  
 eliminate leads going to J9-1 and J9-2  
 on SD101B.

Figure 2-7. SOS and Dynamic Analyzer Interconnection Diagram



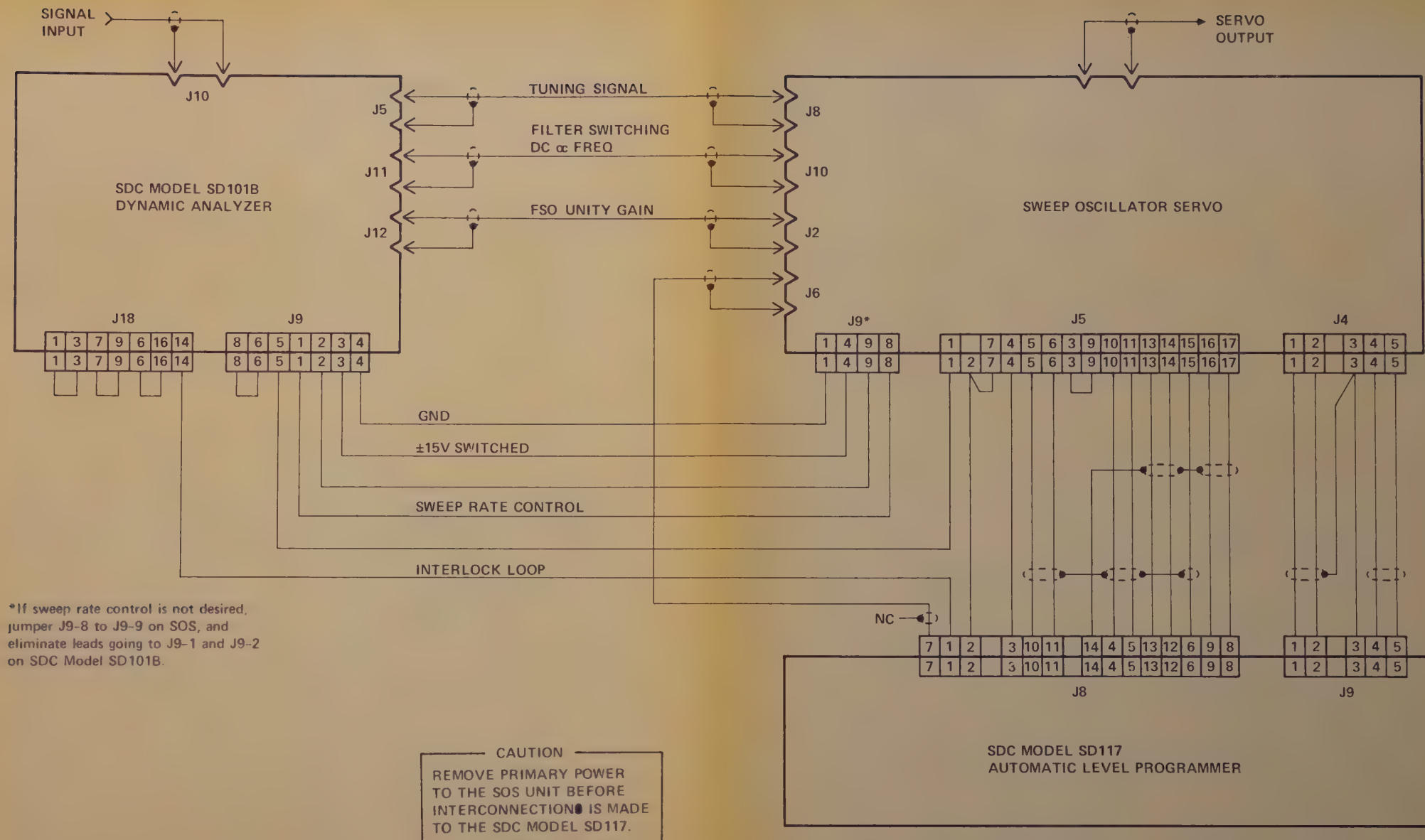


Figure 2-8. SOS, Dynamic Analyzer, and ALP Interconnection Diagram



## SECTION III

### CONCEPT AND THEORY OF OPERATION

#### 3.1 CONCEPT OF OPERATION

The two main sections of the SOS (Sweep Oscillator Servo) are the sweep oscillator section and the servo section. The sweep oscillator section (Figure 3-1) generates and provides the system tuning frequency, and d-c voltages proportional to frequency, that are used by the servo section (Figure 3-2) to provide controlled sinusoidal excitation of a single electrodynamic shaker.

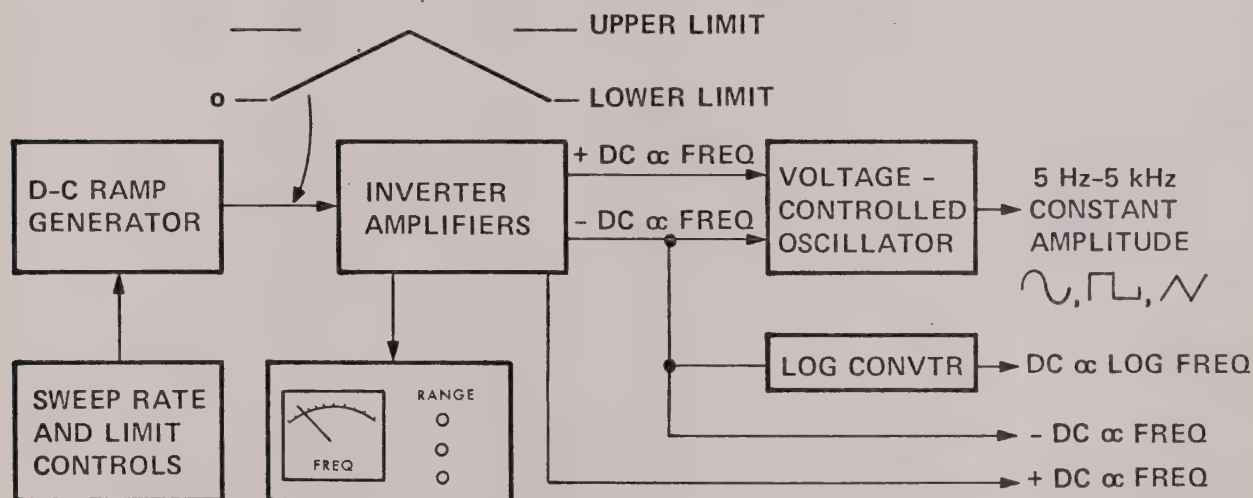


Figure 3-1. Simplified Block Diagram of Sweep Oscillator Section



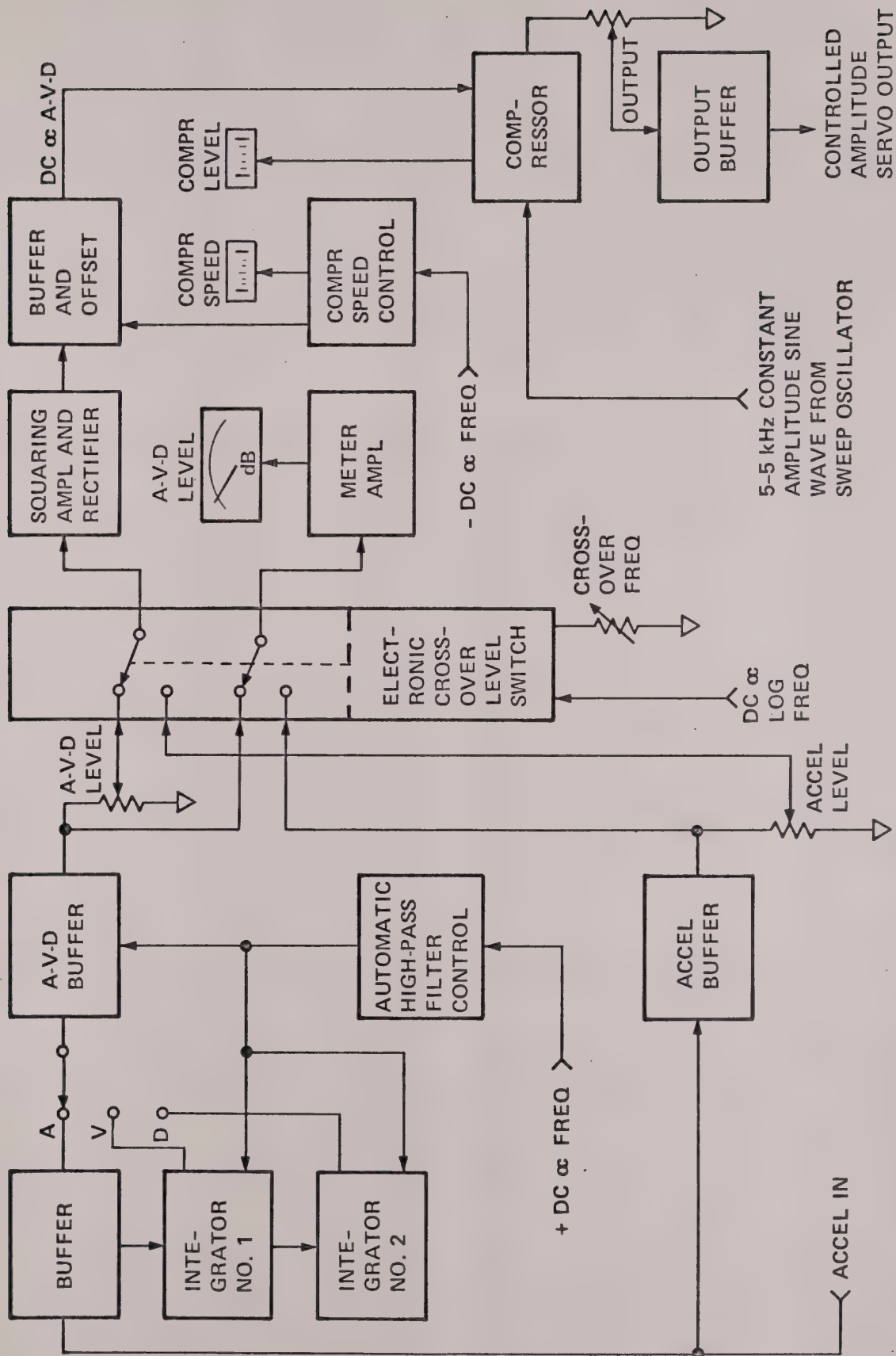


Figure 3-2. Simplified Functional Block Diagram of Servo Monitor Section



## 3.2 BLOCK DIAGRAM DESCRIPTION

### 3.2.1 Sweep Oscillator Section

As shown in the functional block diagram of Figure 3-3, this section comprises a d-c ramp generator, a voltage-controlled oscillator (VCO), sweep rate and limit control circuitry, and frequency meter and range indicator drive circuitry.

The d-c ramp generator produces a symmetrical (positive- and negative- going) linear d-c ramp that is used to voltage-control the VCO frequency. The instantaneous amplitude of the ramp is always proportional to the VCO frequency. Controlling the lower and upper voltage limits of the ramp determines the lower and upper sweep range limits. Varying the slope (rise and fall time) of the ramp controls the sweep rate.

The ramp voltage is amplified, inverted, and applied to a log converter to provide negative and positive d-c outputs proportional to frequency, and a d-c output proportional to the log of frequency.

The 3-decade meter multiplier and range indicator circuitry operates automatically as a function of ramp voltage to provide continuous front-panel indication of the sweep oscillator frequency.

### 3.2.2 Servo Section

This section electronically processes the output from an accelerometer to develop a-c signals proportional to velocity (V) and displacement (D). (See Figure 3-4.) The desired type of control (A, V, or D) and level are selected by the A-V-D range switch/attenuator and associated LEVEL control.

The selected A, V, or D a-c control signal is buffered and then converted (rectified) to a d-c voltage used for controlling the gain of a compressor circuit. The compressor, therefore, servo controls the amplitude of the 5-5 kHz sweep oscillator signal that is applied to the external power amplifier and shaker system.

Automatic level switching (A to A, V to A, or D to A) at a preset frequency is facilitated by the level switching circuit controlled by the  $DC \propto \text{LOG FREQ}$  voltage from the sweep oscillator.

An automatic high-pass filter circuit, controlled by the  $+DC \propto \text{FREQ}$  from the sweep oscillator, provides automatic low-frequency rolloff in the integrator amplifiers as the operating frequency increases. This technique prevents low-frequency saturation at the higher operating frequencies.

Front-panel meters continuously indicate compressor speed, compression level, and the control signal level in dB.



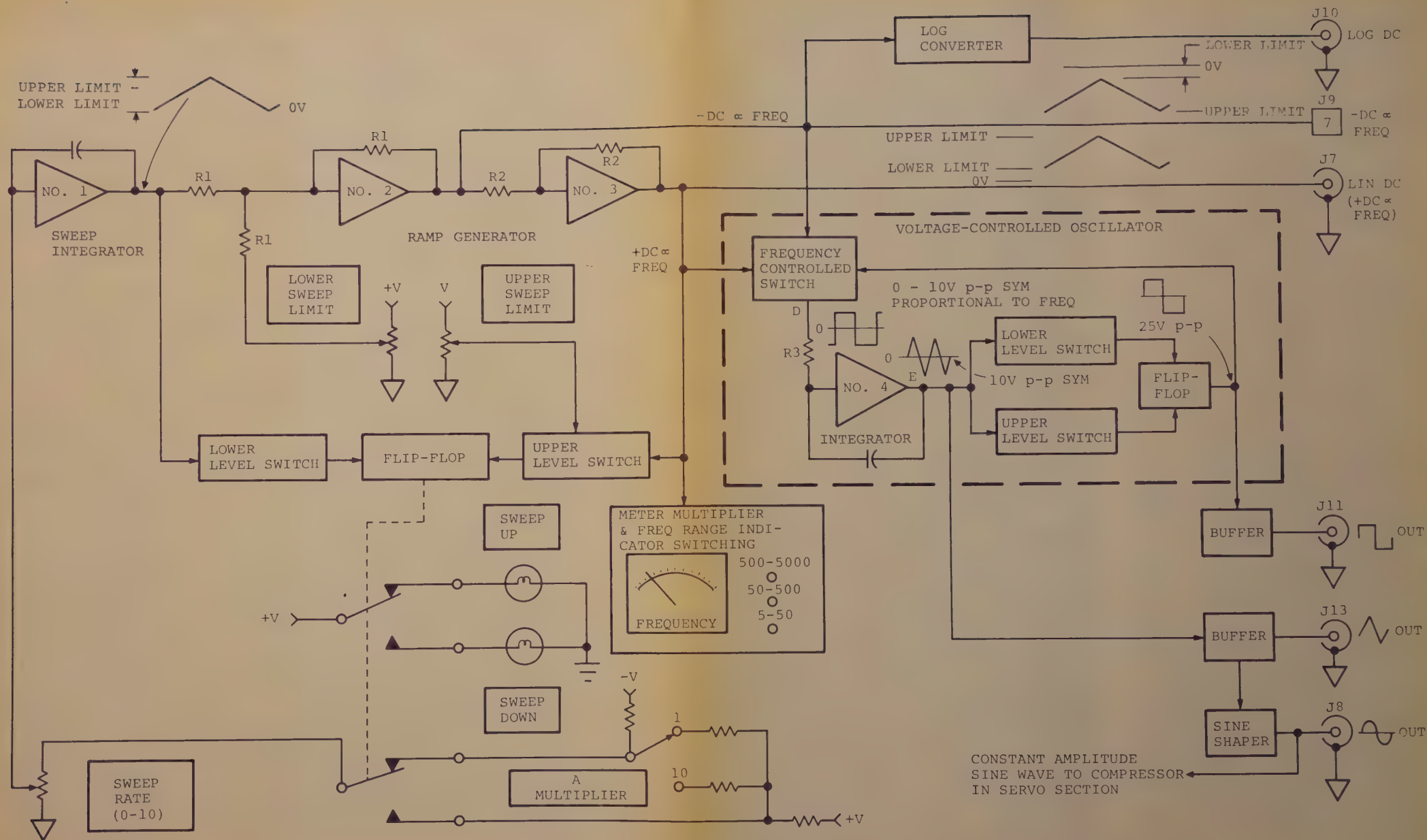


Figure 3-3. Sweep Oscillator Section,  
Functional Block Diagram



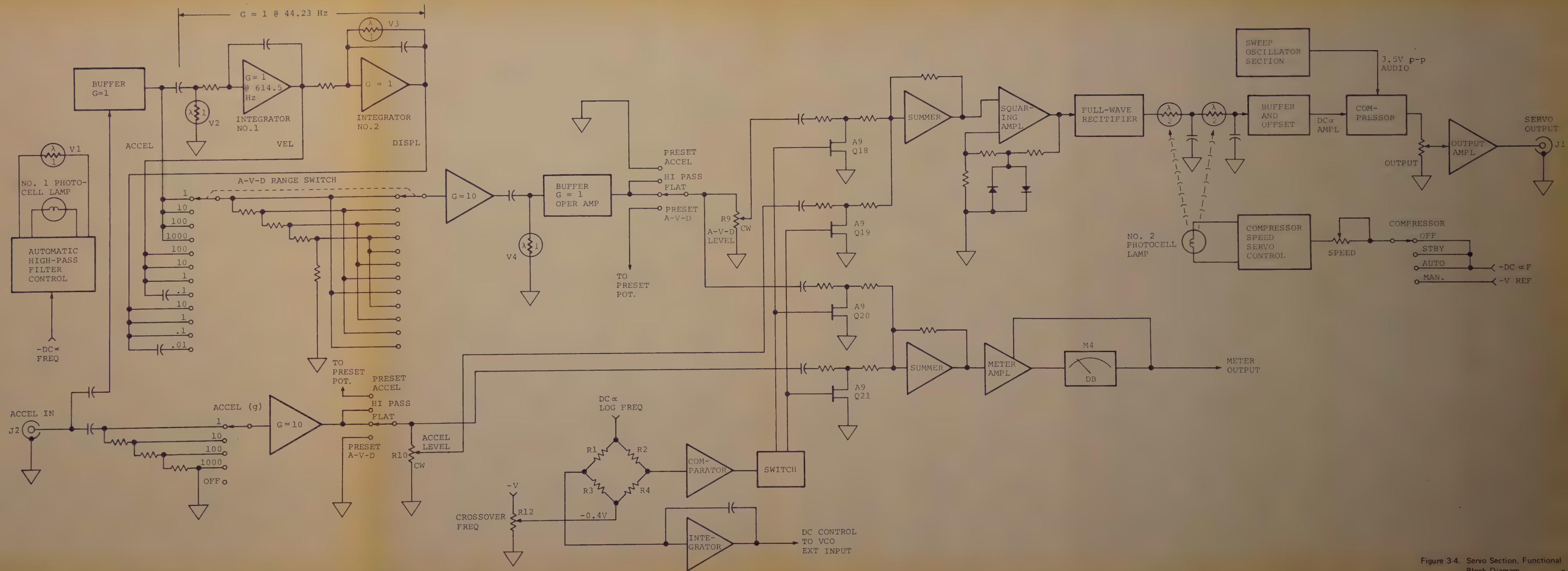


Figure 3-4. Servo Section, Functional Block Diagram



## SECTION IV

### CALIBRATION AND MAINTENANCE

#### 4.1 GENERAL

Before calibrating the instrument, the technician is advised to study carefully Section III of this manual. Refer also to the front-panel and rear-chassis descriptions given in Section I.

Most voltage checks and adjustments can be made with the circuit cards installed. Remove and extend cards only when directed, and then use caution when installing extender and circuit card; be sure to remove power. Figure 4-1 is a top view of the instrument with cover removed, showing all calibration controls.

Note that except for the extender card, each circuit card is individually keyed to its receptacle. Each card is slotted, and a nylon insert is located between two pins of each receptacle. Therefore, the "key" must be removed before the extender can be inserted.

#### NOTE

A layout drawing showing the location of the circuit cards is located on the inside surface of the top cover. On this drawing, the location of each circuit card "key" is denoted by its two adjacent pin numbers. For example, on circuit card A1, the "key" is located between pins 3 and 4.

#### CAUTION

To prevent possibility of plugging a circuit card in the wrong socket, be sure to replace "keys" after calibrating or servicing the instrument.

Throughout the calibration procedure, calibration controls and parts on a circuit card are referenced by their circuit card and part number alphanumeric designator. For example, on Power Supply circuit card A10, R15 is referred to as A10R15. Similarly, circuit card pin connections are referenced by the circuit card alphanumeric designator, a hyphen, pin number/letter; such as A2-F, or A4-16.



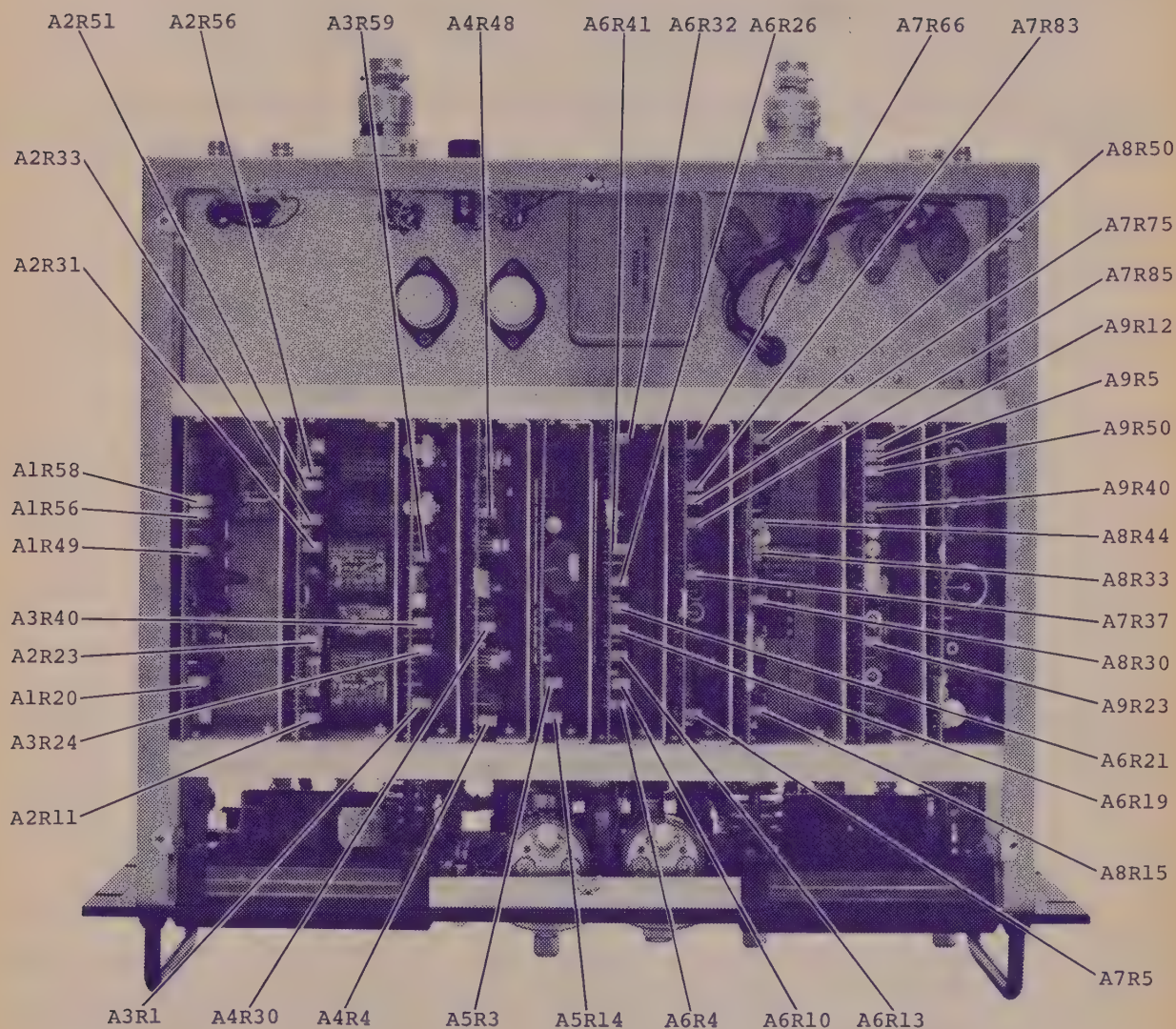


Figure 4-1. Top Chassis View - Calibration Controls



## 4.2 CALIBRATION PROCEDURE

### CAUTIONS

- 1) To ensure proper calibration of the instrument, the following procedure must be performed in its entirety and in the sequence listed.
- 2) Be sure power is off before removing or replacing circuit cards.

Table 4-1 lists the test equipment required; test equipment having equal or better operational characteristics may be substituted.

Table 4-1. Test Equipment Required

| Name                                   | Model No. | Manufacturer    |
|----------------------------------------|-----------|-----------------|
| Attenuator                             | 350D      | Hewlett-Packard |
| DC Power Supply (0-7.5V)               | 6281A     | Hewlett-Packard |
| Digital Voltmeter                      | 3440A     | Hewlett-Packard |
| Ohmmeter Plug-In                       | 3444A     | Hewlett-Packard |
| Distortion Analyzer                    | 330D      | Hewlett-Packard |
| Frequency Counter                      | 5223L     | Hewlett-Packard |
| RMS Voltmeter                          | 323       | Ballantine      |
| Ratio Transformer                      | RT-60     | Gertsch         |
| Volt-Ohmmeter                          | 269       | Simpson         |
| Oscilloscope                           | 561A1     | Tektronix       |
| Time Base Plug-In                      | Type 67   | Tektronix       |
| Wide-Band Calibrated<br>Preamp Plug-In | Type B    | Tektronix       |
| X-Y Recorder                           | 135A      | Moseley         |



#### 4.2.1 Oscillator Section

- a. With the power off, check that all front panel meters are at mechanical zero; i.e., FREQUENCY meter reads 5, DB meter reads 0, COMPR SPEED meter reads 10 dB/s, and COMPR LEVEL meter reads 80 dB. Mechanically adjust if necessary.

- b. Set front-panel controls as follows:

Oscillator Function Switch ..... MAN.  
COMPRESSOR Mode ..... OFF  
OUTPUT ..... PRESET

- c. Check that the 115/230 switch on rear chassis is set properly and correct value of fuse is installed.
- d. Ensure that jumpered plugs P5 and P9 are inserted.

#### NOTE

A 3-minute warmup is sufficient before making the power supply adjustments of steps e. through h. However, at least a 1-hour warmup should be allowed before calibrating the oscillator section beginning with step i.

- e. Connect power cord to primary power source. (There is no power switch on the SD114). Remove top and bottom covers.
- f. Connect DVM and oscilloscope to A10TP4 (-), common to ground lug near power transformer (power supply ground). Adjust A10R15 for  $-15V \pm 10 \text{ mV}$ . Ripple should be less than 1 mV p-p.
- g. Connect DVM and oscilloscope to A10TP3. Adjust A10R12 for  $+15V \pm 10 \text{ mV}$ . Ripple should be less than 1 mV p-p.
- h. Connect DVM and oscilloscope to A10TP8. Adjust A10R23 for  $50V \pm 0.1V$ . Ripple should be less than 1 mV p-p.
- i. Connect oscilloscope to XA5-21, then XA5-22. Chopper drive voltage at both points should be  $\approx 8V$  at  $\approx 800 \text{ Hz}$ .



#### 4.2.1 Oscillator Section (Cont'd)

- j. Adjust COARSE FREQ ADJUST for approximately 25-Hz reading on FREQUENCY meter (5-50 Hz FREQ RANGE indicator is lighted). Connect oscilloscope (calibrated in d-c coupled mode) to XA3-12. Adjust A3R1 (upper adj) so positive-going peak of triangular waveform is 5.00V above ground reference line; adjust A3R24 (lower adj) so negative-going peak is 5.00V below ground reference line.
- k. Connect DVM to J7. Adjust COARSE and VERNIER FREQ ADJUST controls for DVM reading of 9.999V. Now adjust A2R31 (SHUNT) for FREQUENCY meter reading of 5,000 Hz (meter reads 50, 500-5,000 Hz FREQ RANGE indicator is lighted).
- l. Adjust COARSE and VERNIER FREQ ADJUST controls for DVM reading of 100 mV. Adjust A2R33 (SERIES) for FREQUENCY meter reading of 50 Hz (5-50 Hz FREQ RANGE indicator is lighted). Repeat step k., then l. as necessary until both conditions are met.
- m. Adjust COARSE FREQ ADJUST control for FREQUENCY meter reading of approximately 30 Hz (5-50 Hz FREQ RANGE indicator is lighted). Slowly rotate COARSE control clockwise while observing that FREQUENCY meter circuit switches to second decade (50-500 Hz) as meter reads 51 (last marked division). Adjust A2R23 if necessary.
- n. As in step m. above, adjust A2R11 as necessary so meter circuit switches from second to third decade when meter reads 51 (510 Hz).
- o. Connect DVM to XA2-21. Adjust UPPER SWEEP LIMIT control fully counter-clockwise. Set Oscillator Function Switch to LINEAR SWEEP SINGLE and press RESET UP push button. At upper sweep limit, note DVM reading and polarity; it should be between 400 to 900 mV.
- p. Connect DVM to XA2-22 and adjust A2R51 (offset pot.) for equal (but opposite polarity) reading as that noted in step o.
- q. Monitor A2TP7 and adjust UPPER SWEEP LIMIT control for  $\approx 9V$  reading; monitor A2TP6 and adjust A2R56 (balance pot.) for same reading of opposite polarity. Repeat these two adjustments until readings at A2TP6 and A2TP7 are equal  $\pm 2$  mV (opposite polarity).
- r. Press RESET DOWN push button. Monitor A5TP1 and adjust A5R14 (offset pot.) for DVM reading of  $0V \pm 0.01$  mV.



#### 4.2.1 Oscillator Section (Cont'd)

- s. Set Oscillator Function Selector to MAN. Adjust VERNIER FREQ ADJUST control to approximate center of range. Connect DVM to wiper of R2, COARSE FREQ ADJUST, and adjust it for DVM reading of  $10 \text{ mV} \pm 0.01 \text{ mV}$ ; use VERNIER control for fine adjustment.

#### NOTE

For following step, use 1k ohm resistor in series with DVM positive lead to prevent capacitive loading.

- t. Connect DVM to A4TP4 and adjust A4R30 (log offset) for reading of  $-10 \text{ mV} \pm 0.01 \text{ mV}$ . Connect DVM to A4TP7 and adjust A4R48 (lin offset) for reading of  $+10 \text{ mV} \pm 0.01 \text{ mV}$ . Repeat these two adjustments as necessary for proper readings at A4TP4 and A4TP7.
- u. With the oscillator function selector at MAN., adjust both the COARSE and VERNIER FREQ ADJUST controls fully counter-clockwise. Connect oscilloscope probe to J11 and adjust A3R59 (offset pot.) for time symmetry of the square wave.
- v. Set oscillator function switch to LINEAR SWEEP SINGLE. Connect J10, LOG DC OUTPUT, to the X-axis input of an X-Y recorder. Using RESET UP and RESET DOWN push button and LOWER and UPPER SWEEP LIMIT controls, adjust oscillator for full 5-Hz to 5,000-Hz sweep. Using DOWN and UP RESET modes, place pen over left and right margins respectively.

Set oscillator function switch to LINEAR SWEEP AUTO and press RESET DOWN push button. Note exact position of pen at rest on left-hand margin.

Set multiplier A switch to 10 and adjust SWEEP RATE (0-10) control to 3 (30 Hz/s). Momentarily press SWEEP UP; when pen moves about 1 inch to right, press SWEEP DOWN. Pen should return to previously noted left-hand zero position. Repeat this procedure several times, and adjust A1R20 (zero pot.) as necessary to eliminate any zero overshoot or undershoot at 5-Hz (zero) point on recorder graph.

- w. Press RESET UP push button and note exact position of pen over right-hand margin. Operating in a manner similar to step v., press RESET DOWN then RESET UP, and adjust A1R71 (transfer pot.) to eliminate any overshoot or undershoot at 5-kHz (upper limit) point on recorder graph.

#### CAUTION

Be sure power is off before removing or replacing circuit cards in the following step.



#### 4.2.1 Oscillator Section (Cont'd)

- x. Remove circuit cards A3 and A4 from chassis. Connect a 10k ohm, 5%, ¼W resistor from A6TP4 to A6TP6; connect a jumper wire from A6TP5 to ground. Re-apply power. Connect DVM to A6TP4; ground DVM to convenient point on card. Adjust A6R32 (zero pot.) for reading of  $0V \pm 0.02 \text{ mV}$ .

Connect DVM to A6TP6 and adjust A6R41 (lin pot.) for reading of  $0V \pm 0.02 \text{ mV}$ .

Disconnect power, remove 10k ohm resistor and jumper, reinstall circuit cards A3 and A4, and re-apply power.

- y. Connect the X-axis of an X-Y recorder (with 3-cycle log paper in place) to J10, LOG DC OUTPUT. Connect DVM to J7, LIN DC OUTPUT.

With oscillator function switch set to MAN., use FREQ ADJUST controls to calibrate recorder X-axis over the 3 decades, from 10 mV to 10V as read on the DVM.

Adjust FREQ ADJUST controls so pen is placed on first decade point. DVM should read  $100 \text{ mV} \pm 1.5 \text{ mV}$ .

Adjust FREQ ADJUST controls so pen is placed on second decade point. DVM should read  $1 \text{ V} \pm 15 \text{ mV}$ .

#### NOTE

If the above accuracy cannot be obtained, slight re-adjustment of A6R41 (lin pot.) may be required. If necessary, adjust FREQ ADJUST controls for DVM reading of 20 mV; pen should rest over "2" line, or first division of first decade. If error exists, adjust A6R41 (lin pot.) so as to double the error. Recalibrate recorder end points at 10 mV and 10V settings and recheck linearity as described above.

- z. Set oscillator function switch to LINEAR SWEEP SINGLE and press DOWN RESET push button. Press SWEEP UP; when the FREQUENCY meter indicates about 25 Hz (center of first decade), press the HOLD push button. Observe DVM reading (at J7); after first 5-minutes, adjust A5R3 (hold adjust) for minimum upward drift.
- aa. Connect DVM to A4TP7, and adjust FREQ ADJUST controls (MAN. mode) for DVM reading of 100 mV. Adjust A3R40 (freq pot.) for 50 Hz (200 ms period) as measured on frequency counter at J8 (sine wave output).
- bb. Connect oscilloscope to A3TP10. Adjust the oscilloscope in d-c mode for external sweep mode so that the trace is a vertical line. Increase Y-axis gain so top and bottom of vertical line presentation can be still seen by adjusting the Y-axis positioning controls.



#### 4.2.1 Oscillator Section (Cont'd)

##### bb. (Cont'd)

Adjust the SOS for a single linear sweep, 5 Hz to 5 kHz. Alternately press the RESET DOWN and RESET UP push buttons. Adjust A3C18 and A3C19 to minimize the amplitude variation in the triangular wave over the frequency range of 5 Hz to 5 kHz; the variations in both the positive and negative peaks should be symmetrical with respect to ground. A3C18 affects bottom of trace, and A3C19, the top.

- cc. Connect frequency counter to J8. Using MAN. mode, adjust oscillator for each of the following frequencies as read on the FREQUENCY meter. The counter reading and tolerance are given in the second column.

| <u>FREQUENCY meter (Hz)</u> | <u>Counter reading (Hz)</u> |
|-----------------------------|-----------------------------|
| 5,000                       | 5,000 $\pm 100$             |
| 4,000                       | 4,000 $\pm 80$              |
| 2,000                       | 2,000 $\pm 40$              |
| 500                         | 500 $\pm 10$                |
| 200                         | 200 $\pm 4$                 |
| 50                          | 50 $\pm 1$                  |

- dd. Set SWEEP RATE (0-10) control R3 to 0 (zero) and multiplier A to 1. Connect DVM to wiper of R3; reading should be not greater than 1.12 mV.
- ee. Set oscillator function selector to LINEAR SWEEP AUTO, SWEEP RATE control to 10, and multiplier A to 10. Use counter and ensure sweep-end limits are 5 Hz and 5 kHz.

#### NOTE

To measure sweep times in the following steps, operate counter in TIME INTERVAL mode. Connect counter INPUT to applicable connection listed below for proper counter trigger voltage.

|                       |            |                |
|-----------------------|------------|----------------|
| Collector A1Q9 (TP4): | Up-sweep   | $\approx -15V$ |
|                       | Down-Sweep | $\approx +12V$ |
| Collector A1Q10:      | Up-sweep   | $\approx +12V$ |
|                       | Down-sweep | $\approx -15V$ |

Initiate and time a single up-sweep. Time should be 49.95 seconds  $\pm 0.4$  seconds; adjust A1R56 (fast pot.) for proper sweep time. Set multiplier A to 1; up and down sweep times should be 499.5 seconds  $\pm 5.0$  seconds. Adjust A1R58 (slow pot.) for proper sweep time.



#### 4.2.1 Oscillator Section (Cont'd)

ee. (Cont'd)

Set oscillator function selector to LOG SWEEP AUTO and multiplier A to 10. Reset sweep limits to 5 Hz and 5 kHz. Initiate and time a single up-sweep. Time should be 18 seconds  $\pm 0.1$  second; adjust A4R4 (log gain) for proper sweep time.

ff. Using MAN. mode, adjust FREQ ADJUST controls for FREQUENCY meter reading of 5 Hz. Counter connected to J8 should read 5 Hz  $\pm 0.1$  Hz (period is 196 to 204 ms). If necessary, select new value for A2R5 (located between A2E1 and A2E2).

gg. Remove power, remove circuit card A6, and unsolder one end of jumper wire located on left side of A6R7. Re-install circuit card A6, and re-apply power. Allow a 5-minute warmup.

In MAN. mode, adjust output for 200 Hz. Connect distortion analyzer (H-P 330D) and oscilloscope probe to J8. Adjust A6R26 for sine wave amplitude of 3.5V p-p.

If distortion is 0.3 percent or more, turn A6R19 clockwise  $\frac{1}{4}$  turn; then optimize A6R13 and A6R21. (A6R10 may be adjusted, but is normally in its extreme counter-clockwise position.) If necessary, to reduce distortion, repeat this procedure by turning A6R19 clockwise in  $\frac{1}{4}$ -turn increments and optimizing A6R13 and A6R21 until no further improvement is noted.

If the preceding procedure does not lessen the distortion, turn A6R19 counter-clockwise in  $\frac{1}{4}$ -turn increments, each time optimizing A6R13 and A6R21 until no further improvement is noted.

#### NOTE

For best results in optimizing the potentiometers, stay at least 3 turns from either extreme. If necessary, select new values for factory-adjust resistors A6R12, A6R20, and A6R22.

Remove power, remove circuit card A6, reconnect and solder jumper wire (at left of A6R7), re-insert A6, and apply power. Allow a 5-minute warmup.

hh. If distortion is not less than 0.2 percent, adjust A6R4 for minimum distortion; if necessary, adjust also A6R10 and A6R13.

Adjust A6R26 for 3.5V p-p sine wave at J8.



#### 4.2.1 Oscillator Section (Cont'd)

hh. (Cont'd)

Check the distortion at the following frequencies:

| <u>Frequency (Hz)</u> | <u>Percent Distortion Allowable</u> |
|-----------------------|-------------------------------------|
| 5,000                 | 0.5                                 |
| 2,000                 | 0.3                                 |
| 20                    | 0.3                                 |
| 10                    | 0.5*                                |
| 5                     | 0.5                                 |

\*Adjust A3R59 (offset pot.) for minimum distortion at 10 Hz.

#### 4.2.2 Servo Section

- a. Remove jumpered plug P5 at rear of chassis. Connect DVM (with ohms plug in) between A9TP12 and circuit ground (across V4 in photocell unit).

Adjust oscillator for 1-kHz output. Adjust A9R12 (1 kHz adj) for DVM reading of 1.2 megohms, +0.2 megohm, -0.

Adjust oscillator for 5-Hz output. Adjust A9R5 (5 Hz adj) for DVM reading of 1.2 megohms, +0.2 megohm, -0.

Re-insert jumpered plug P5.

- b. Set COMPRESSOR switch to OFF. Use BNC "T" at J2 (ACCEL IN) and connect short jumper coaxial cable to J1. Also at J2 apply a 614-Hz signal (period = 1.627 ms) at 70.7 mV  $\pm$  0.7 mV rms.

Connect rms voltmeter to A9TP4 (velocity out), and adjust A9R23 (int. No. 1) for reading of 70.7 mV rms  $\pm$  0.7 Vrms.

Connect rms voltmeter to A9TP5 (displ out), change frequency to 44.23 Hz (22.61 ms), and adjust A9R40 (int. No. 2) for reading of 70.7 mV  $\pm$  0.7 mV rms.

Ensure correct polarity connections across A9C13.

- c. At J2, apply 1-kHz signal at 7.07 mV  $\pm$  0.07 mV rms. Turn CROSSOVER FREQ adjust (front panel) counter-clockwise until ACCEL CONTROL indicator lights. Set ACCEL (g) range selector to 1. Adjust A7R37 (gain adj) for full scale reading on DB meter. Select new value for A7R47 if necessary.

Turn CROSSOVER FREQ adjust clockwise until A-V-D CONTROL indicator lights. Adjust A9R50 (gain adj) for full-scale reading on DB meter.



#### 4.2.2 Servo Section (Cont'd)

- d. Set A-V-D range selector to .01 DISPL (INCHES P-P), OUTPUT control fully counter-clockwise (PRESET detent), ACCEL (g) range selector to OFF, and using MAN. mode, adjust oscillator frequency to 5 Hz. Insert 20 dB attenuation between J1 and J2. The noise level as read on the DB meter should be less than 0.001 (average) with occasional peaks not higher than 0.003.
- e. Refer to paragraph 2.2.2 and set up instrument to preset crossover frequency at 1000 Hz  $\pm 1$  Hz.

Using MAN. mode, adjust oscillator frequency to approximately 700 Hz; then increase frequency to above 1000 Hz. Crossover switching should occur at 1000 Hz  $\pm 1$  Hz; adjust A7R5 (sw adj) for proper switching.

When manually sweeping down, hysteresis should be less than 2.5 percent of frequency; i.e., switching should occur before 975 Hz for 1000-Hz crossover setting.

- f. Use 1k ohm resistor in series with DVM "hot" lead and connect to A2TP6 (dc  $\propto$  freq). Using MAN. mode, adjust frequency for DVM reading of  $-10 \text{ mV} \pm 0.01 \text{ mV}$ . Connect DVM to A7TP8 and measure  $\approx -24 \text{ mV}$ ; select new value for A7R56 if necessary.
- g. Use DVM with ohms plug-in unit and connect across A8V4 (photocell assembly). Set COMPRESSOR switch to AUTO. Adjust FREQ ADJUST and COMPRESSOR SPEED controls for DVM reading of 3.3k ohms.

Adjust A7R85 (full scale adj) for reading of 3k dB/s on COMPR SPEED meter.

Set oscillator frequency to 5 Hz, SPEED control to maximum clockwise. Adjust A7R66 (offset) for DVM reading of 250k ohms.

Adjust FREQ ADJUST controls only for DVM reading of 100k ohms. If necessary, select value of A7R86 for reading of 100 dB/s on COMPR SPEED meter.

Turn SPEED control fully counter-clockwise and adjust A7R75 (zero adj) for a reading of 10 dB/s on COMPR SPEED meter.

Repeat adjustments for A7R85 and A7R75 as necessary.

- h. Turn SPEED control fully counter-clockwise, set COMPRESSOR selector to AUTO, and adjust oscillator for 5 Hz. COMPR SPEED meter should read approximately 10 dB/s and DVM (across A8V4) should read 1.0 megohms or more.



#### 4.2.2 Servo Section (Cont'd)

##### h. (Cont'd)

Set COMPRESSOR switch to AUTO, turn LIMIT and SPEED controls fully clockwise, and adjust oscillator frequency to 3 kHz. COMPR SPEED meter should read above 3k dB/s.

Turn SPEED control fully counter-clockwise; COMPR SPEED meter should read below 1k dB/s.

- i. Connect an attenuator (set to 20 dB) between J1 and J3. (See Figure 2-1 in Section II.) Refer to TEST CONDITIONS listed on schematic diagram; adjust instrument accordingly.

With DVM, measure approximately 8.9V at A8TP5. Adjust A8R44 (dc adj) for equal voltage reading at A8TP6 and A8TP5.

- j. Connect distortion analyzer to SERVO OUTPUT (J1). Use BNC "T" so loop can be closed. Set COMPR SPEED to 1k DB/s and OUTPUT control fully clockwise. Adjust ACCEL LEVEL and RANGE for an OUTPUT at J1 of approximately 1V p-p.

Adjust A8R30 (bal adj) for minimum distortion, 1 percent or less.

- k. Adjust ACCEL LEVEL and OUTPUT controls and increase external attenuation (between J1 and J2) as necessary to obtain 40V p-p at J1.

Adjust A8R33 (0 dB adj) for a reading of 0 dB on COMPR LEVEL meter.

Adjust the controls and attenuator to obtain 40 mV p-p at J1. Then adjust A8R50 (60 dB adj) for reading of -60 dB on COMPR LEVEL meter.

Repeat adjustments of A8R33 (at 40V output) and A8R50 (at 40 mV output) for best-fit meter readings.

- l. Set COMPRESSOR switch to AUTO, OUTPUT control fully clockwise (PRESET detent), and OPERATE/PRESET switch to PRESET A-V-D. Adjust PRESET LEVEL for reading of 1 on DB meter. Turn A-V-D LEVEL control fully counter-clockwise.

Adjust A8R15 (offset pot.) so COMPR LEVEL meter can be pegged just below the 80 dB mark.

- m. Set the COMPRESSOR to STBY. Observe the SERVO OUTPUT at J1, and adjust A8R70 until the compressor has gone into compression to the point where the OUTPUT just stops decreasing.



### 4.2.3 Performance Checks

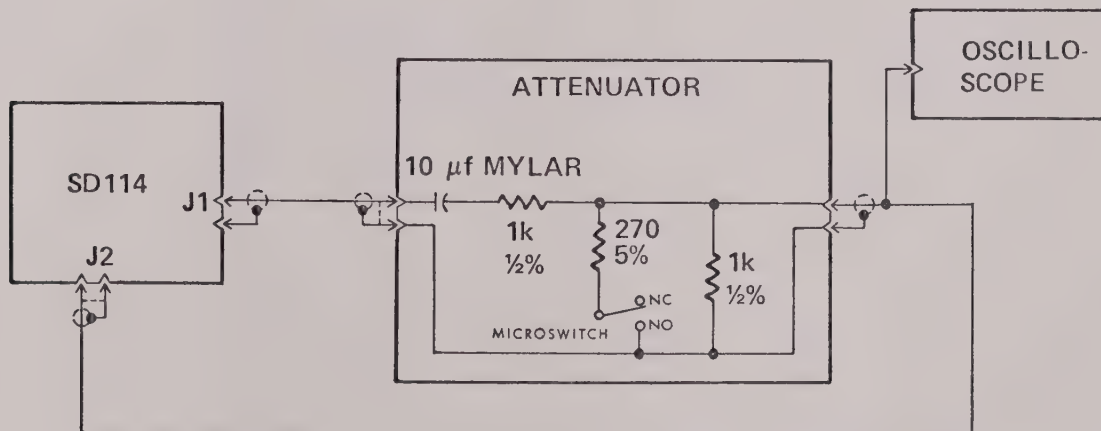
- a. Correction Accuracy: Remove the attenuator and connect a ratio transformer (RT) between J1 and J2. (Use "T" at J2.) Adjust RT for -60 dB (00100). Connect rms voltmeter (3 mV range) to "T" at J2. Adjust oscillator for 1 kHz. Set ACCEL (g) selector to OFF and A-V-D range switch to 1g ACCEL. Adjust OUTPUT control fully clockwise. Adjust A-V-D LEVEL for reading of -2.0 dB on rms voltmeter ( $\approx 0.4g$ ). Set ratio transformer to following setting and read specified values on rms voltmeter:

| <u>Ratio Transformer</u> | <u>RMS Voltmeter</u> |
|--------------------------|----------------------|
| -40 dB (01000)           | Less than -1.6 dB    |
| -20 dB (10000)           | Less than -1.2 dB    |
| 0 dB (X0000)             | Less than -0.8 dB    |

- b. Dynamic Range: Remove RT and insert attenuator (0 dB) between J1 and J2. (Insert a 4.7k ohm resistor between J1 and input to attenuator.) Connect rms voltmeter (Ballentine) and oscilloscope to J1.

Set A-V-D range switch to 1000g ACCEL and adjust A-V-D LEVEL control clockwise until OUTPUT just starts to show clipping; then back off control slightly for a clean OUTPUT signal. Note rms voltmeter reading. Set COMPRESSOR switch to STBY and note new reading. The difference between the two readings should be greater than 80 dB.

- c. Compressor Speed: Connect the instrument and test equipment as shown below:



A standard step-attenuator can be used; however, a fast-acting switchable 10 dB attenuator is desirable and recommended; the circuit is shown in the attenuator block. The attenuator should be built in a small metal box for complete shielding of all parts.



### 4.2.3 Performance Checks (Cont'd)

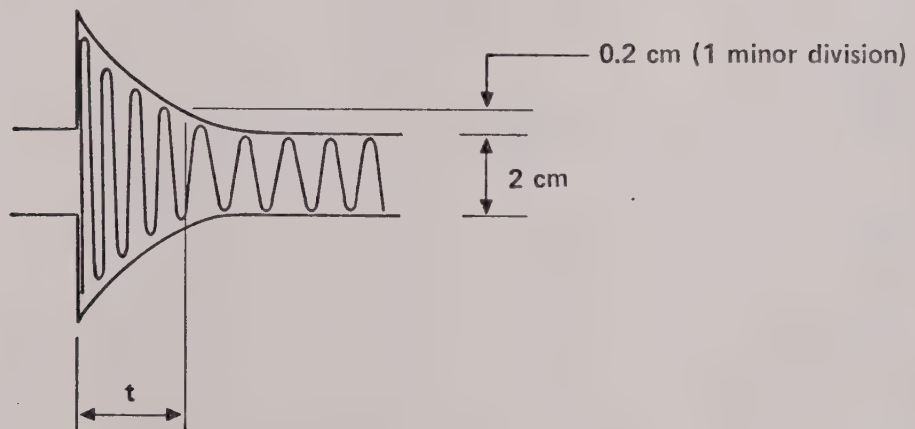
#### c. (Cont'd)

Measure the compression speed between 20 dB and 30 dB compression for each of the following frequencies and indicated speeds.

| <u>Frequency</u> | <u>COMPR SPEED<br/>Meter Reading</u> | <u>*Measured</u> | <u>*Measured<br/>Equivalent Speed</u> |
|------------------|--------------------------------------|------------------|---------------------------------------|
| 3 kHz            | 3k dB/s                              | 2.5-4.8 ms       | 2,100-3,900 dB/s                      |
| 100 Hz           | 100 dB/s                             | 77-143 ms        | 70-130 dB/s                           |
| 5 Hz             | 10 dB/s                              | 0.67-2 seconds   | 5-15 dB/s                             |

$$\text{*Compressor speed (dB/s)} = \frac{10}{\text{Seconds}}$$

At a frequency of 3 kHz, adjust instrument to control at 30 dB as read on COMPR LEVEL meter. Insert 10 dB attenuation (press microswitch); meter should read 20 dB. Remove the 10 dB attenuation (release microswitch) while observing oscilloscope pattern. Meter will go from 20 to 30 dB; t should be from 2.5 to 4.8 milliseconds. This time corresponds to a speed of 2,100 to 3,900 dB/s. See output waveform pattern below.



- d. To verify the overall operation of the instrument, perform the Operational Check of paragraph 2.2 in Section II of this manual.



### 4.3 PARTS REPLACEMENT

Except for some special SDC specification-controlled parts listed in Table 4-2, which must be ordered from Spectral Dynamics Corporation, standard electronic parts have been used throughout the instrument. Spectral Dynamics Corporation maintains a complete stock of all parts and complete printed circuit card assemblies used in this instrument.

When ordering a replacement part or assembly, be sure to include the reference designation, the part number or manufacturers designation, and a complete description; include also the instrument name, model number, and serial number.

Table 4-2. Special Replaceable Parts List

| Ref. Des. | Description                                                                    | Part No.<br>Mfr. Des. |
|-----------|--------------------------------------------------------------------------------|-----------------------|
| A1        | Low Frequency Switching Assembly                                               | 11244-1               |
| A2        | Relay Switching/Meters Assembly                                                | 11242-1               |
| A3        | Hi-Freq Switching/Hi-Freq Integrator Assembly                                  | 11246-1               |
| A4        | Log Linear Scaler/Inverter Amplifier Assembly                                  | 11358-1               |
| A5        | Sweep Integrator/Chopper Drive Assembly                                        | 11354-1               |
| A6        | Sine Shaper/Log Converter Assembly                                             | 11356-1               |
| A7        | Meter Ampl, Crossover Switch, Preset Integrator, and<br>Speed Control Assembly | 11362-1               |
| A8        | Compressor/Speed Control Assembly                                              | 11364-1               |
| A9        | A-V-D/ACCEL/Hi-Pass/FET Buffers Assembly                                       | 11366-1               |
| A10       | Power Supply Assembly                                                          | 11360-1               |
|           | Printed Circuit Board Assembly                                                 | 11616-1               |
| A1Q15     | 2N3638A (SDC spec pair)                                                        | 20013-074             |
| A2Q3,Q4   | 2N3391A (matched pair)                                                         | 20013-045             |
| A2Q2      | 2N3638A                                                                        | 20013-074             |
| A2Q9,Q10  | 2N3391A (matched pair)                                                         | 20013-051             |
|           | (Cont'd)                                                                       |                       |



### 4.3 PARTS REPLACEMENT (Cont'd)

Table 4-2. Special Replaceable Parts List (Cont'd)

| Ref. Des. | Description                                                             | Part No.<br>Mfr. Des. |
|-----------|-------------------------------------------------------------------------|-----------------------|
| A3Q10,Q11 | 2N1305,2N1304 (matched)                                                 | 20013-042             |
| A7Q14,Q15 | 2N3391A (matched pair)                                                  | 20013-044             |
| A8C12     | K6BC20K 68 $\mu$ f, 20V                                                 | 20013-125             |
| A8Q12,Q13 | 2N3391A (matched pair)                                                  | 20013-044             |
| DS1,2,3   | Lamp, FREQ RANGE indicator                                              | CF03-WTS-2102         |
| DS9,10    | Lamp, A-V-D and ACCEL CONTROL indicators                                | CF03-GTS-2102         |
| DS11      | Lamp, INTERLOCK indicator                                               | CF03-YTS-2102         |
|           | Photo Cell Assembly                                                     | 10292-1               |
| M1        | Frequency meter                                                         | 20013-039             |
| M2        | Compressor Speed meter                                                  | 20013-218             |
| M3        | Compressor Level meter                                                  | 20013-219             |
| M4        | DB meter                                                                | 20013-095             |
|           | Knob, COARSE FREQ ADJUST, OPERATE/PRESET<br>OUTPUT, Oscillator Function | 20013-175             |
|           | Knob, COMPRESSOR, ACCEL (g), A-V-D                                      | 20013-176             |
|           | Knob, SPEED, LEVEL                                                      | 20013-177             |
|           | Knob, VERNIER FREQ ADJUST                                               | 20013-191             |
| R1        | Vernier Freq Adjust                                                     | D49M-50/5             |
| R2        | Coarse Freq Adjust                                                      | 3500S-419-502         |
| R3        | Sweep Rate (0-10) control                                               | 3500S-2-103           |
| R4        | (Refer to S3)                                                           | ---                   |
|           | (Cont'd)                                                                |                       |



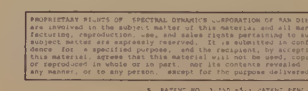
### 4.3 PARTS REPLACEMENT (Cont'd)

Table 4-2. Special Replaceable Parts List (Cont'd)

| Ref. Des.                | Description                        | Part No.<br>Mfr. Des. |
|--------------------------|------------------------------------|-----------------------|
| R5/S13                   | Output control/Preset switch       | 93504A                |
| R6                       | Speed Limit control                | HML-1K                |
| R7                       | Lower Sweep Limit control          | 20013-066             |
| R8                       | Upper Sweep Limit control          | 3507S-3-502           |
| R9                       | (Refer to S9)                      | ---                   |
| R10                      | (Refer to S10)                     | ---                   |
| R11                      | (Refer to S11)                     | ---                   |
| R12                      | Crossover Freq control             | 78PR1K                |
| S1                       | A 1/10 Sweep Rate Multiplier       | 7101                  |
| S2                       | Oscillator Mode switch             | 20013-054             |
| S3/R4                    | Compressor Mode/Compressor Speed   | 20013-077             |
| S4/DS4<br>thru<br>S8/DS8 | Sweep/Reset/Hold switch assemblies | 20013-220             |
| S9/R9                    | A-V-D Range/Level control          | 20013-221             |
| S10/R10                  | ACCEL Range/Level control          | 20013-222             |
| S11/R11                  | Preset/Operate/Level control       | 20013-223             |
| S12                      | 115/230 switch                     | 46256LF               |
| T1                       | Power Transformer                  | 20013-212             |
|                          | Power Cord                         | Belden 17258          |





[illegible]



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